THESIS/
REPORTS
Foresman,
K.R.

FINAL REPORT FOR RESEARCH AGREEMENT
INT-96030-RJVA
"Testing of Forest Carnivore Survey Methods
for Wildlife Monitoring"
UNIVERSITY OF MONTANA
FS Contact: Dr. L. Jack Lyons
CoOp Contact: Dr. Kerry R. Foresman

APPLICATION OF REMOTE SENSING METHODS FOR THE DETECTION OF FOREST CARNIVORES AND THEIR PREY BASE IN BITTERROOT NATIONAL FOREST

Kerry R. Foresman
Professor of Biology
Division of Biological Sciences
University of Montana
Missoula, MT 59812

Michael T. Maples
Wildlife Research Technician
Division of Biological Sciences
University of Montana
Missoula, MT 59812

TABLE OF CONTENTS

Introduction....1

Acknowledgments....2

Section I: Remote Sensing Camera Survey....2

- Methods....3
- Results....8
  - Big Creek Study Area....8
  - Bear/Fred Burr Ridge Study Area....14
  - Lolo Pass/Snowshoe Falls I Study Area....19
  - Grant Creek Study Area....25
  - Miller/Plant Creek Study Area....29
  - Montana Border Study Area....34
  - Lolo Pass/Snowshoe Falls II Study Area....35
  - Overall Camera Survey Summary....37

Section II: Tracking Plate Survey....42

- Methods....42
- Results....44
  - Grant Creek Study Area....48
  - Miller/Plant Creek Study Area....52
  - Burdette Creek Study Area....56
  - Upper Lost Park Study Area....58
  - Lupine Creek Study Area....60
  - Montana Border Study Area....62
  - Bear Creek Study Area....65
  - Bear/Fred Burr Ridge Study Area....68
  - Big Creek Study Area....71
  - Sweeney Creek Study Area....74
  - Lolo Pass/Snowshoe Falls Study Area....79

Recommendations....83

Literature Cited....85

Appendix 1. Latency to Detection Graph.

Appendix 2. Species List.

Appendix 3. Habitat Sampling Form.

INTRODUCTION

In 1994-95 the University of Montana and the USDA Forest Service Intermountain Research Stations embarked on a joint research venture to test three proposed survey techniques (Zielinski & Kucera 1995) of four important mid-level forest carnivores: lynx (*Lynx lynx*), wolverine (*Gulo gulo*), fisher (*Martes pennanti*), and American marten (*Martes americana*). Determining the presence of such rare or difficult to detect species as these four mid level forest carnivores has become essential in managing public lands. In the past, this information has been absent from land managers' data bases. Developing sound techniques where data has meaningful form and scientific rigor is integral. Therefore the standardized sampling procedures of Zielinski and Kucera (1995) were continued to be tested and utilized in 1996 by the University of Montana and the USDA Forest Service Intermountain Research Station, Missoula, Montana.

Testing and use of the method closely followed the 1995 effort with the following exceptions:

1) Snow tracking was omitted in the 1996 effort based on the results of the 1995 effort that it was the least accurate and standardized method of the three proposed.

2) The study area was expanded to additional sites on both the Bitterroot National Forest and the Lolo National Forest.

3) The 1996 effort sampled during the late winter, spring, summer, and early fall seasons whereas the 1995 focused on winter and spring sampling.

4) During the 1996 season we focused on detection of the prey base for the forest carnivores.

ACKNOWLEDGMENTS

We would like to acknowledge several individuals who helped during the course of this study. Scott Tomson, Jay Kolbe, and Rick Amon volunteered their time and efforts in the field. Dean Pearson provided advice and helped set up the habitat sampling format. Denver Holt provided assistance when a field technician was injured. The initial suggestion for this study was provided by Dr. L. Jack Lyon, whose continued interest in, and support for, this research was appreciated.

SECTION I: REMOTE-SENSING CAMERA SURVEY

Kucera et al. (1995) addressed three remote-sensing camera systems (110-style camera, the Trailmaster system, and the Manley camera system). The 1995 testing effort by Foresman and Pearson (1995) examined one of those systems: the Manley system manufactured locally (Tim Manley, 524 Eckleberry Drive, Columbia Falls, Montana 59912). The Manley camera system was deemed the most suitable for long-term surveys of forest carnivores and was thus chosen for testing the camera survey protocols of Kucera et al. (1995). In 1996, the testing of the camera survey protocols continued with a few modifications:

1) Although Manley camera systems were again utilized in the testing procedures, the majority of the cameras tested were TM 500 camera systems, a product of Goodson & Associates, Inc. (10614 Widmer, Lenexa, KS 66215). Both the Manley and the TM 500 systems employ passive infrared and microwave senors which require both heat and motion to trigger, are capable of taking multiple photographs, and monitor a wide and adjustable field of view. We included the TM 500 system in the survey testing because it has more adjustment capability than the Manley system, exhibited the potential to operate more

consistently than the Manley system, is lighter weight than the Manley system, and costs less than the Manley system to purchase and operate.

2) The cameras were employed as survey tools for additional species besides the four forest carnivores. Camera sets were developed to survey the prey base (i.e. the small mammal populations) and to survey species or individuals which avoid the typical forest carnivore baited set. Foresman and Pearson (1995) suggested that species such as mountain lion (*Felis concolor*) and coyote (*Canis latrans*) actively avoided the standard camera sets.

3) The survey durations (number of active camera days) were varied, depending on the type of survey being conducted.

4) Different terrain features and habitat types were sampled. In 1995, the survey effort was restricted to second order drainages of the Bitterroot Mountains. In 1996, the survey effort included second order drainages and ridge tops of the Bitterroot Mountains as well as many third and fourth order drainages and ridge tops in the Lolo National Forest. In 1996, the survey effort included a wide variety of habitat types, from dry ponderosa pine (*Pinus ponderosa*) sites to moist lower subalpine sites.

5) The camera stations were sampled late winter through spring and late summer in 1996, where as in 1995 the sampling effort was concentrated during the winter months.

METHODS

First Suite of Cameras

Big Creek Study Area: Two Manley camera systems and two TM 500 camera systems were placed in this study area. Before going into the field, the cameras system were tested in the office to insure that they functioned properly. Both camera systems used similar cameras; either the Yashica AW Mini or Olympus Weather-Proof. Both cameras have an effective flash distance of approximately 4 m. In order to ensure proper film exposure, it was important to position the camera within 4 m of the target location in the field of view for both the Manley and the TM 500 camera systems. The Manley camera systems were set approximately one mile apart. The Manley camera stations were set in the same fashion as Foresman and Pearson (1995) and Kucera et al. (1995):

> Cameras stations were baited by suspending a front or hind quarter of road-killed deer (*Odocoileus* spp.) between two trees by a rope. A piece of monofilament string was dangled from the carcass to approximately 1 m above the ground and a feather or piece of aluminum foil was tied to the end to provide a visual attractant and a central point for directing the camera's field of view. The Manley cameras were mounted 2-3 m from the ground by bolting them to a tree. A climbing harness and spikes were used to mount and access the cameras. Date and time were set on the cameras and the cameras were fitted with 3 volt lithium batteries. Twelve volt tractor batteries or twelve volt dry cell batteries were fitted in the Manley cameras to power the sensors. Stations were scented with commercial trapping lures. After mounting the cameras and centering the field of view on the visual attractant the sensor field was restricted using magnets to match it with the viewing field. A sign was placed within the viewing field identifying the camera station.

The TM 500 camera systems were placed approximately 40 m from the Manley camera systems. The TM 500 system consists of a camera, a camera shield, a 25' cable, a sensor, a small tripod, and a strap. The TM systems were blind sets; meaning they were not baited in any fashion. The sensory field of these camera systems were directed towards potential travel routes used by individuals or species actively avoiding detection. Trails or natural corridors located on the periphery of the bait sets were utilized. The sets were placed 3-4 m above ground on trees and camouflaged with branches to further prevent detection by a wary individual or species. The sensors were attached to the trees with the strap. On large diameter trees it was often necessary to use two straps. Approximately one half meter above the sensor the tripod was nailed to the tree with two 8d nails. The camera was attached to the tripod and the tripod was adjusted to position the camera with the desired field of view. Then, the range of the sensor was adjusted to monitor the camera's field of view. A piece of wood of appropriate size was wedged behind the top of the sensor to angle the sensory field towards the ground and the target position. The TM 500 sensors have a set up feature which verifies the area being monitored. If needed, tape was applied to the outer surfaces of the sensor to narrow the sensitivity range. A sign was placed within the viewing field identifying the camera station.

The cameras were then walk tested. This involved walking through the sensor field with the camera activated to assure that the camera units were functioning properly. If the camera failed, attempts were made to repair the deficiency. When the camera refused to function despite all attempts to remedy the problems, the camera was replaced with a spare camera. After a camera system passed a walk test, a 36 exposure roll of 400 ASA color slide film was installed. One more walk test was then completed to initialize the roll of film with a test photo giving the time and date the station was set.

Foresman and Pearson (1995) found it necessary to modify the protocol of Kucera et al. (1995) regarding the checking of cameras from every 14 days to every 7 days. Cameras in 1996 were checked on four to five day intervals to further assure that bait stations were being monitored constantly. When checking cameras, we walk tested them on arrival to determine whether they were still monitoring the bait set. Notes were kept as to the condition of the set upon arrival, the tracks present, and status of the camera. Three-volt lithium camera batteries were tested and changed if they fell below 2.8 volts. Twelve-volt sensor batteries were tested and changed if they fell below 11 volts. Adjustments were made to sensor fields, sensitivity, and time-delays as needed to insure that subjects would be within range before cameras were triggered and to minimize film waste on highly visited sites. Film was changed when approximately >2/3 the roll had been exposed. Baits were replaced as needed.

Bear/Fred Burr Ridge Study Area: Two Manley camera systems and two TM 500 camera systems were placed in this study area. Three of the monitoring stations were baited carnivore sets in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Two Manley camera systems and one TM 500 camera system were employed for the three baited sets. The baited sets in this study area were designed to survey drier ridge top habitats. The camera systems were set to the protocol described above. The fourth set, a TM 500 camera system, was designed to survey the prey base/small mammal population.

Small mammal survey stations typically had the camera's field of view focused in a tree well, dead fallen log, root wad, or other suitable micro habitat for small mammals such as mice, voles, squirrels, and hares. Cameras were mounted approximately one meter above the ground and approximately two meters from the bait. Peanut butter and rolled oats were used for bait. Camera system set up followed the protocol described above.

Lolo Pass/Snowshoe Falls I Study Area: One Manley camera system and three TM 500 camera systems were placed to survey this study area. The single Manley system was a blind set along a potential travel route. It was set to the protocol described above. No bait was employed at this station. The purpose of this was to detect individuals or species which totally avoid baited sets.

Two of the TM 500 systems were set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). The baited stations in this study area were designed to survey ridge top habitats and small, ephemeral streams. The camera systems were set to the protocol described above. The fourth camera system, a TM 500, was a small mammal survey station set to the protocol described above.

Second Suite of Cameras

Grant Creek Study Area: Three TM 500 camera systems were placed in this study area. One camera system was set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). The baited station in this study area was designed to survey a major drainage habitat. The camera system was set to the protocol described above. Two camera systems were set to survey small mammals populations. Of those two, one was baited with peanut butter and rolled oats and one was baited with peanut butter, rolled oats, fish, and fish oil rolled into a ball approximately 7 cm diameter. Both were set to the protocol described above.

Plant Creek Study Area: Four TM 500 camera systems were placed in this study area. Two camera systems were set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). The camera systems were set to the protocol described above. Two camera systems were set to survey small mammal populations. Both were set to the protocol described above.

Third Suite of Cameras

Montana Border Study Area: One TM 500 camera system was placed in this study area. The station was a blind set; no bait was employed at this set. The camera system was set to the protocol described above. The purpose of this set was to detect species or individuals moving along a narrow, forested corridor between tracts of undisturbed timber. The area between the tracts and bordering the corridor had been clear cut.

Snowshoe Falls II Study Area: One TM 500 camera system was placed in this study area. The camera system was set to monitor both a closed and an open baited track plate. The camera system was set to the protocol described above. The purpose of this set was to obtain photo confirmation to match up with the tracks of the individuals entering the track plates.

The film collected from the stations was developed and the slides were analyzed with an Olympus 7.5x-64x microscope. Date, time, and content were recorded on the slide with a permanent marker and the slides were sheathed in plastic covers and placed in ring binders. Slide data (exposure number, date, time, event number, photo, and number of active camera days) was entered into SPSS statistical software (SPSS Inc., 444 N. Michigan Avenue, Chicago, IL 60611). Slides were identified with the four letter code for the species identified, NA if nothing was visibly apparent in the slide, NO IMPR if the date/time did not register on the slide, BD EXP if the exposure was too poor to read the slide, and TEST if the slide was exposed during a camera visit.

Habitat variables were sampled at each station. Variables included habitat type (Pfister et al. 1977), dominant cover species, estimation of age class with in 15 m of set, estimation of course woody debris within 15 m of set (Fischer 1981), distance to water, squirrel midden, and trail or road, dbh, species and type of snags within 15 m of set, and a vertical structure designation following O'Hara et al. (1996). GPS coordinates (Map Datum: NAD27CONUS) were recorded for each location. A sample habitat data form can be found in Appendix I.

RESULTS

First Suite of Cameras

Two of the four target species were recorded with the first suite of cameras: marten and fisher. Marten were observed in all three study areas. Fisher were observed in two of the three study areas: Bear/Fred Burr Ridge and Lolo/ Snowshoe Falls I. Mean latency to detection at the 7 baited sets was:

Species	Actual Days	Active Camera Days
Fisher	10.75 +/- 6.5 (SD)	6.0 +/- 3.7 (SD)
Marten	16.0 +/- 13.3 (SD)	12.3 +/- 9.5 (SD)

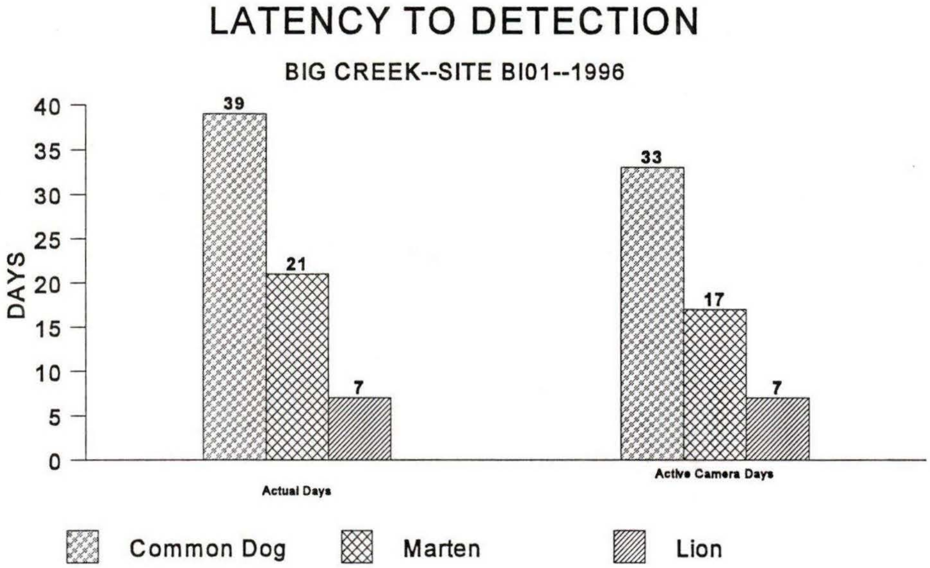
Non-target species and small mammal species detected included mountain lion, coyote, red squirrel (*Tamiasciurus hudsonicus*), deer mice (*Peromyscus maniculatus*), red-backed vole (*Clethrionomys gapperi*), red-tailed chipmunk (*Tamias ruficaudus*), snowshoe hare (*Lepus americanus*), black-capped chickadee (*Parus gambeli*), dark-eyed junco (*Junco hyemalis*), varied thrush (*Ixoreus naevius),* Stellar's jay (*Cyanocitta cristata*), and gray jay (*Perisoreus canadensis).*

Camera Station Descriptions

Big Creek Study Area

Site: BI01 Section: #10 Township/Range: T.8N.R.21.W

Site employed a baited Manley camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site was located along an old irrigation canal (UTM Coords: 713595 x 5149507) which parallels Big Creek to the south. Habitat type keyed to *Abies grandis/Linnaea borealis*. Dominant cover species (in order of dominance) were Douglas fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), and lodgepole pine (*Pinus contorta*). Overstory age class medium I to Medium II (9'-21' dbh). Course woody debris estimated at 15 tons/acre. Stand vertical structure evaluated between young and old multi-strata. Distance to water: @125 m; squirrel midden: 6 m; trail: approximately 50 m. One lodgepole snag 10" dbh was within a 15 m radius of the set. Snow conditions at set initiation: approximately one meter compacted snow with a thick crust. No surface powder. Tracks/Sign at set initiation: Difficult to assess due to snow conditions. Two pine marten scats were observed on the road approximately



one-quarter mile east of the trail head. Red squirrel tracks were observed along the old canal. Camera operation: Upon installation it failed to function properly and had to be replaced with a back-up camera. The back-up camera (also a Manley) function properly.

Camera station BI01 time table:

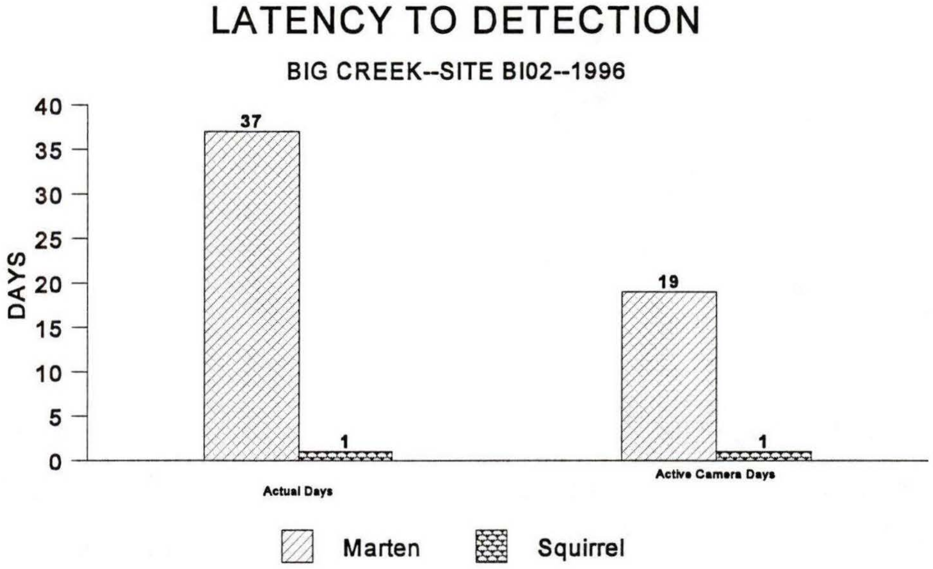
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
21FEB96--05APR95	44 days	38 days	6 days

Camera station BI01 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
52	52	5 (10%)	4 (8%)	22 (42%)	17 (33%)	24 (46%)	2 (4%)

Site: BI02 Section: #10 Township/Range: T.8N.R21W.

Site employed an unbaited TM 500 camera system set in a blind fashion. Site was located 15 m east of BI01. Habitat type keyed to *Abies grandis/Linnaea borealis*. Dominant cover species (in order of dominance) were Douglas fir, western larch, and lodgepole pine. Overstory age class medium I to Medium II (9'-21' dbh). Course woody debris estimated at 15 tons/acre . Stand vertical structure evaluated between young and old multi-strata. Distance to water: @ 125 m; squirrel midden: 27 m; trail: approximately 50 m. Snow conditions at set initiation: approximately one meter compacted snow with a thick crust. No surface powder. Tracks/Sign at set initiation: Difficult to assess due to snow conditions. Two pine marten scats were observed on the road approximately one-quarter mile east of the trail head. Red squirrel tracks were observed along the old canal. Camera operation: Camera functioned properly upon installation. Boughs used to camouflage the camera fell in front of the sensor between 14-19 MAR 96 and triggered the camera 448 times.



Camera station BI02 time table:

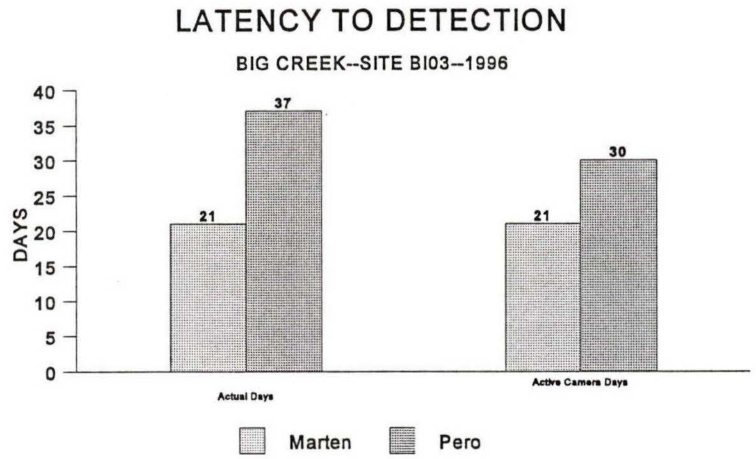
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
21FEB96--05APR95	44 days	25 days	19 days

Camera station BI02 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
525	76	1 (1.3%)	5 (6.6%)	29(38%)	58(76%)	12 (16%)	0 (0%)

Site: BI03 Section: #9 Township/Range: T.8N.R.21W.

Site employed a baited Manley camera system set in a the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site located approximately one mile from the Big Creek trailhead (UTM 713230 x 5149630); across one channel of the creek (approximately 125 m north of the trail) on an island. The island was approximately 100 m wide and 200-250 m long. Habitat type keyed to *Thuja plicata/Aralia nudicaulis*. Dominant cover species was western red cedar (*Thuja plicata*). Overstory age class large (>21" dbh). Course woody debris estimated at 10-12 tons/acre. Stand vertical structure evaluated old forest single-stratum. Distance to water: 20m; squirrel midden: NA; trail: 125 m. No snags within 15 m of set; one western larch snag 24" dbh approximately 40 m from set. Snow conditions at set initiation: approximately 1 m of old, crusted snow, with 3 cm of fresh powder (previous's night's snowfall). Tracks/Sign at set initiation: nine sets of marten crossed the road between the turn off to the trail head and the trail head. All sets within a 300 m stretch of road; therefore assumed to be one individual. Red squirrel and snowshoe hare tracks along trail. Possible marten tracks also along trail. Cow moose (*Alces alces*) and calf fed along creek while the camera was set up. Camera operation: Camera functioned properly upon installation.



Camera station BI03 time table:

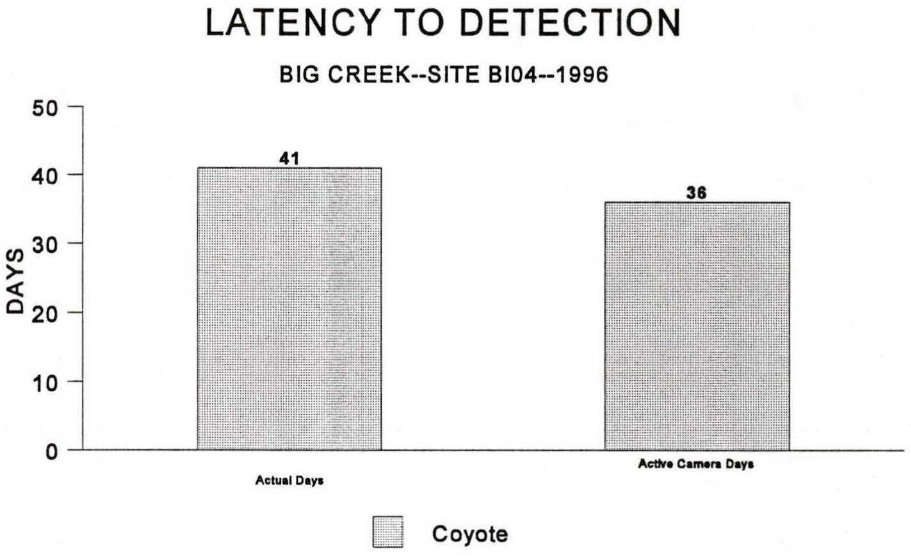
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
26FEB96--05APR95	39 days	30 days	9 days

Camera station BI03 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
113	76	16 (21%)	1 (1.3%)	2(2.6%)	30(39%)	24 (32%)	5 (7%)

Site: BI04 Section: #9 Township/Range: T.8N.R.21W.

Site employed an unbaited TM500 camera system set in a blind fashion. Site located approximately 30 m north of BI03 (UTM 712230 x 5149630). Habitat type keyed to *Thuja plicata/Aralia nudicaulis*. Dominant cover species was western red cedar. Overstory age class large (>21" dbh). Course woody debris estimated at 10-12 tons/acre. Stand vertical structure evaluated old forest single-stratum. Distance to water: 10 m; squirrel midden: NA; trail: 125 m. Snow conditions and tracks/sign at set initiation: same as BI03. Camera operation: Camera functioned properly upon installation.



Camera station BI04 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
26FEB96--05APR95	39 days	36 days	3 days

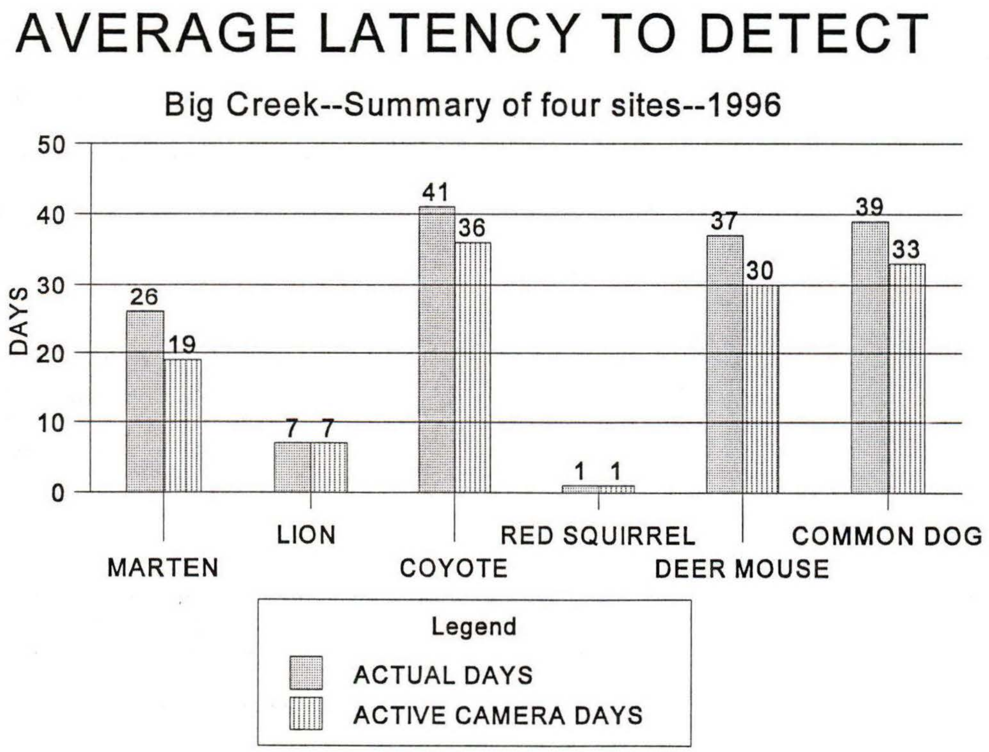
Camera station BI04 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
93	84	0 (0%)	1 (1.2%)	46(55%)	67(80%)	16 (19%)	0 (0%)

Summary of Big Creek Camera Survey

Survey Time Table:

	Survey Duration	Active Camera Days	Down Camera Days
Total	166	129 (77.7%)	37 (22.3%)
Mean	41.5	32.25	9.25
Stand. Dev.	2.9	5.9	6.9



Big Creek Survey Photo Table:

	EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
TOTAL	783	288	22 (8%)	11 (4%)	99(34%)	172(60%)	76 (26%)	7 (2%)
MEAN	195.75	72	5.5	2.75	24.75	43.0	19.0	1.75
ST. DEV.	220.96	13.86	7.33	2.10	18.21	23.14	6.0	2.36

Bear/Fred Burr Ridge Study Area

Site: BE01 Section: #18 Township/Range: T.7N.R.21W.

Site employed a baited Manley camera system set in a the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site located approximately one quarter mile west of the ridge road (UTM 710993 x 5138008). Habitat type keyed to *Pseudotsuga menziesii/Calamagrostis rubescens*. Dominant cover species was Douglas fir (75%) and ponderosa pine (25%). Overstory age class large (>21" dbh). Course woody debris estimated at <9 tons/acre. Stand vertical structure evaluated old forest multi-strata. Distance to water: NA; squirrel midden: 62 m; trail: NA. One 16" dbh snag of unknown species within a 15 m radius of the set. Snow conditions at set initiation: approximately 1 m of old, crusted snow; no surface powder. Tracks/Sign at set initiation: difficult to assess; red squirrel and hare tracks in the vicinity. Camera operation: Camera functioned properly upon installation. Sometime between 22-25MAR96 the Yashica AW-Mini camera quit functioning. The entire Manley camera system was replaced with a TM 500 camera system on 26MAR96.

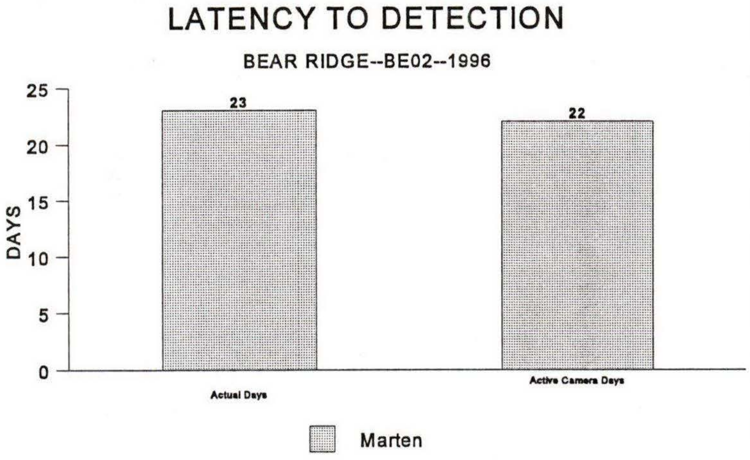
Camera station BE01 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
04MAR96-04APR96	31 days	27 days	4 days

Camera station BE01 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
12	12	0 (0%)	0(0%)	12 (100%)	0 (0%)	12(100%)	0 (0%)

Site: BE02 Section: #18 Township/Range: T.7N.R.21W.



Site employed a baited Manley camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). This site was located along a small east facing drainage on the ridge between Fred Burr and Bear Creeks; approximately 800 m west of the ridge road (UTM 710708 x 5138793). Habitat type keyed to *Pseudotsuga menziesii/Vaccinium globulare*. Co-dominant cover species were Douglas fir, ponderosa pine, Engelmann spruce (*Picea engelmanni*), and western larch. Overstory age class large (>21" dbh). Course woody debris estimated at <9 tons/acre. Stand vertical structure evaluated old forest multi-strata. Distance to water: 45 m; squirrel midden: 35 m; trail: NA. Snow conditions at set initiation: approximately one and a half meters of compacted snow with a thick crust. No surface powder. Tracks/Sign at set initiation: Difficult to assess due to snow conditions. Snowshoe hare, squirrel, and weasel (*Mustela erminea*) in creek bottom. Lion and deer tracks observed along road. Camera operation: Camera function properly upon installation.

Camera station BE02 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
29FEB96-04APR96	36 days	32 days	4 days

Camera station BE02 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
24	24	2 (8%)	0(0%)	1 (4%)	1 (4%)	20(83%)	1 (4%)

Site: BE03 Section: 13 Township/Range: T.7N.R.22W.

Site employed a baited TM 500 camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). This site was located along the ridge between Fred Burr and Bear Creeks; camera set was located in a saddle approximately 8 km west of the ridge road (UTM 709497 x 5138155). Surrounding area composed of much exposed rock, avalanche chutes, and steep wooded slopes. Habitat keyed to *Abies lasiocarpa/Xerophyllum tenax*. Co-dominant cover type was subalpine fir (*Abies lasiocarpa*) and lodgepole pine. Overstory age class was Medium I (9"-15" dbh). Course woody debris estimated at 9 tons/acre. Stand vertical structure evaluated as understory reinitiation. Snow conditions at set initiation: approximately two meters compacted snow with a thick crust. No surface powder. Tracks/Sign at set initiation: Difficult to assess due to snow conditions. Snowshoe hare, squirrel, lion, and coyote tracks observed along hike to set. Camera operation: Camera functioned properly upon installation.

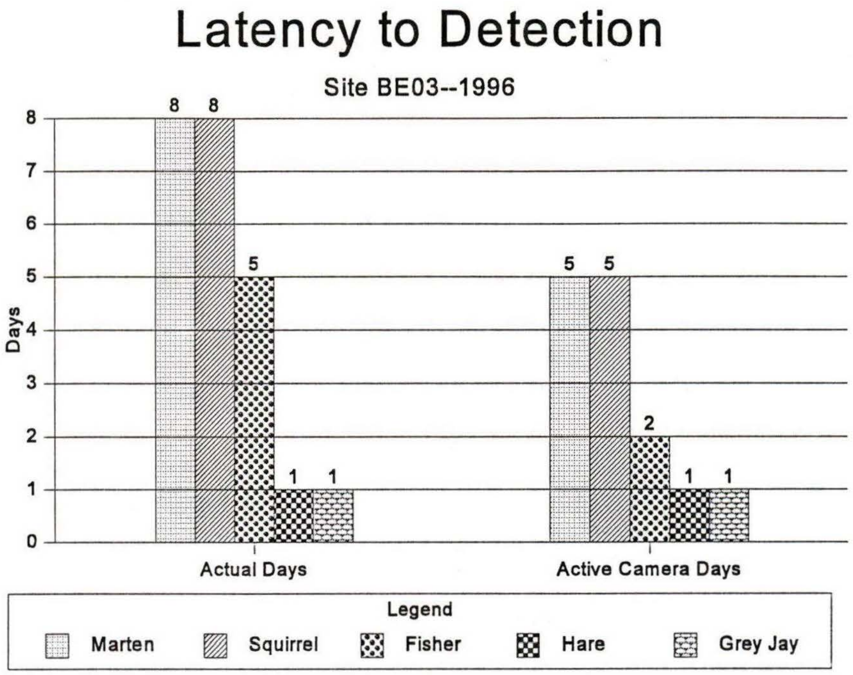
Camera station BE03 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
04MAR96-04APR96	31 days	20 days	11 days

Camera station BE03 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
251	118	39(33%)	16(14%)	2 (2%)	42(36%)	21(18%)	0 (0%)

Time Intervals:
LEAM to MAPE = 10:36 (n=1)
MAPE to MAAM = 10:45 (n=1)
MAAM to MAPE = 3:30 (n=1)
MAPE to TAHU = 3:14 (n=1)
TAHU to MAPE = 0:03 (n=1)



Site: BE04 Section: 18 Township/Range: T.7N.R.21W.

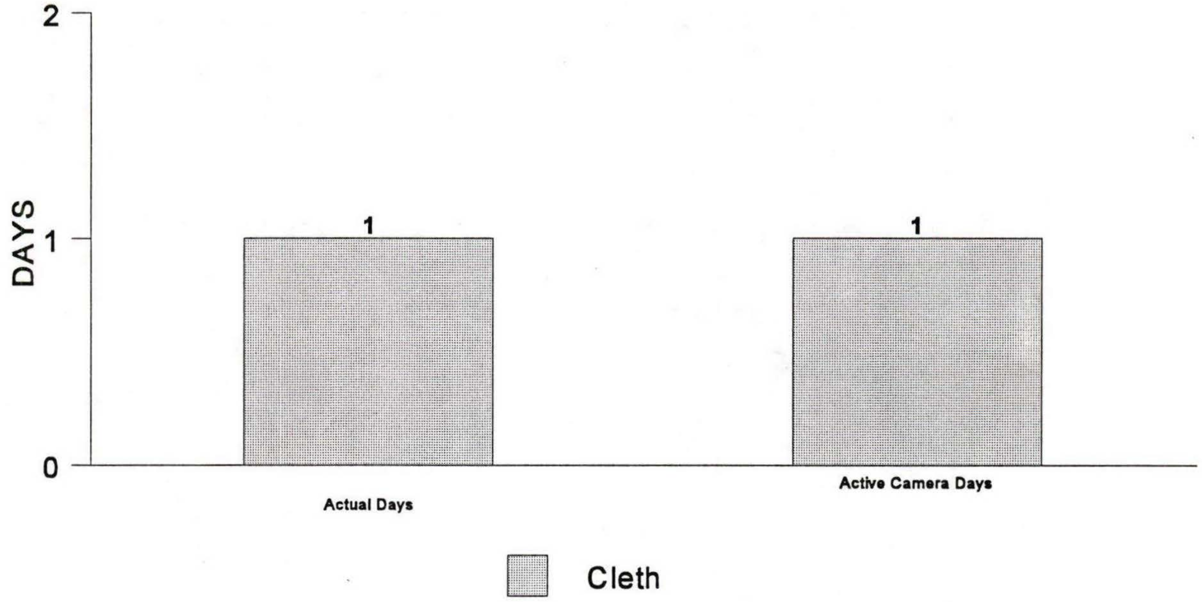
Site employed a baited TM 500 camera system set to detect small mammals. For bait, rolled oats were distributed on a log approximately 2 m from the camera. This site was located along a small east facing drainage on the ridge between Fred Burr and Bear Creeks; approximately 500 m west of the ridge road (no UTM--poor GPS coverage). Habitat keyed to *Picea/Clintonia uniflora*. Dominant cover species was Engelmann spruce. Overstory age class was Medium II (15"-21" dbh). Course woody debris estimated between 10-13 tons/acre. Stand vertical structure evaluated between young and old forest multi-strata. Distance to: water 2 m; squirrel midden 5 m; trail: NA. One snag of unknown species (16" dbh) within 15 m radius of set. Snow conditions at set initiation: approximately one and a half meters of compacted snow with a thick crust. No surface powder. Tracks/Sign at set initiation: Difficult to assess due to snow conditions. Snowshoe hare , red squirrel, and weasel in creek bottom. Camera operation: Camera functioned properly upon installation.

Camera station BE04 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
22MAR96-04APR96	13 days	3 days	10 days

LATENCY TO DETECTION

BEAR RIDGE--SITE BE04--1996



Camera station BE04 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
66	38	9(24%)	-------	0 (0%)	27(71%)	2(5%)	0 (0%)

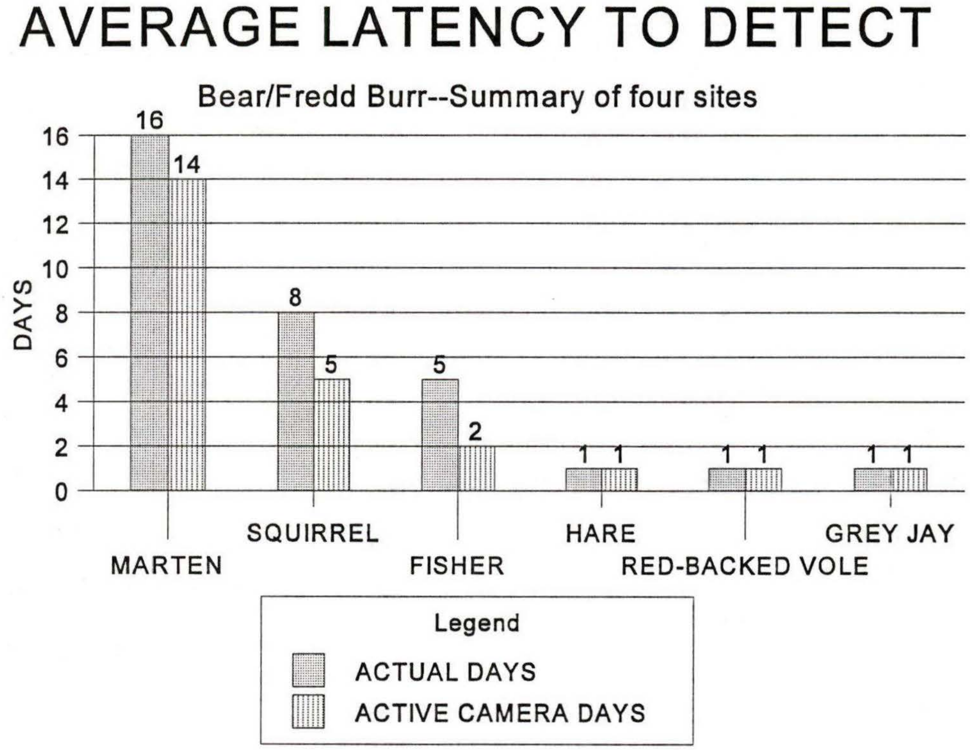
Summary of Bear/Fred Burr Camera Survey

Survey Time Table:

	Survey Duration	Active Camera Days	Down Camera Days
Total	111	82 (74.0%)	29 (26.0%)
Mean	27.75	20.5	7.25
Stand. Dev.	10.1	12.7	3.8

Carnivore Survey Only Photo Table:

	EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
TOTAL	287	154	41(27%)	16(10%)	15(9.7%)	43(28%)	53 (34%)	1(0.6%)
MEAN	95.7	51.3	13.7	5.3	5.0	14.3	17.7	0.3
ST. DEV.	134.7	58.0	22.0	9.2	6.1	24.0	4.9	0.6



Lolo Pass/Snowshoe Falls I Study Area

Site: Lo01 Section: #25 Township/Range: T.11N.R.24W.

Site employed an unbaited Manley camera system set in a blind fashion. Site was located approximately one quarter of a mile north of U.S. Highway 12 (UTM 686420 x 5172460). Habitat variables were not recorded at this site due to field technician injury. Snow conditions at set initiation: approximately 1.5 m of packed snow with approximately 2" of surface powder. Tracks/Sign at set initiation: red squirrel, hare, coyote, weasel, and possible marten track within 200 m of set. Camera operation: Camera would not function properly upon installation. Spare camera, also a Manley, would not function properly either. Third Manley system functioned properly.

Camera station Lo01 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
27FEB96-05APR96	38 days	31 days	7 days

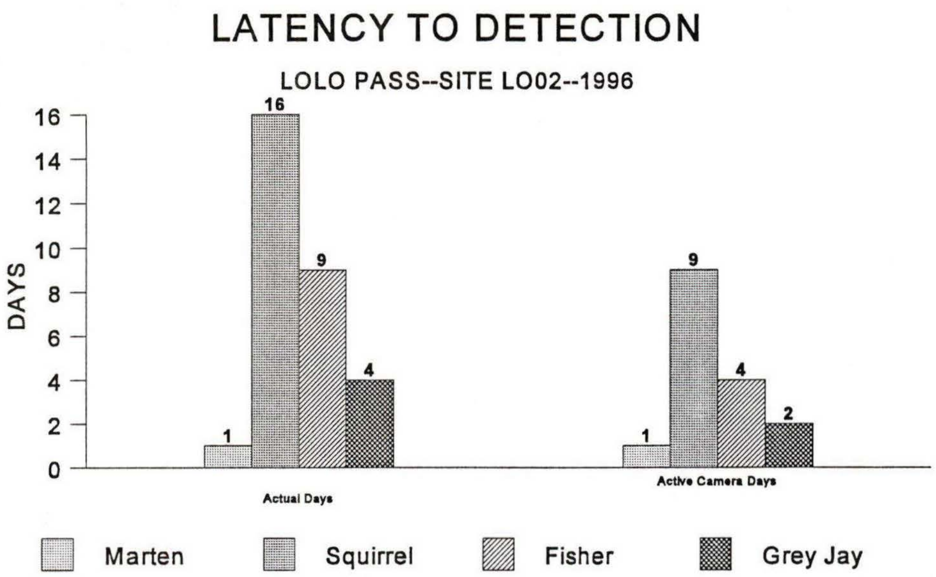
Camera station Lo01 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
53	53	0 (0%)	0(0%)	30(57%)	15(28%)	31 (58%)	7 (13%)

On 05MAR96 and 26MAR96 very large canid tracks were observed in the vicinity of Site Lo01. Track measurements (front foot): length = 11.1 cm; width = 10.8 cm; plantar pad width = 5.1 cm; toe pad length = 2.5 cm; and distance between toes and claws = 1.3-1.9 cm. Stride on a walking gait (rear foot registering in front track) averaged 1.12 - 1.18 m. The tracks were followed for approximately three-quarters mile each occasion. Given track dimensions and behavior assume animal to be a wolf (*Canis lupus*). On 20MAR96, this same individual triggered camera Lo01. The individual did not appear in the photograph as the field of view on the camera and the sensor field were not perfectly matched. It was estimated that the wolf was one meter outside the camera's field of view when it was triggered by the sensor.

Site: Lo02 Section: #26 Township/Range: T.11N.R.24W.

Site employed a baited TM 500 camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site was located approximately three quarters of a mile north of U.S. Highway 12 (UTM 685540 x 5172520). Habitat variables were not recorded at this site due to field technician injury. Snow conditions at set initiation: approximately two meters



of snow with a thick crust. No surface powder. Tracks/Sign at set initiation: Possible pine marten tracks were observed in the drainage. Red squirrel in area also. No snowshoe hare tracks observed. Camera operation: Initial camera system had a defective cable. The back-up camera functioned properly.

Camera station Lo02 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
26FEB96-05APR96	39 days	25 days	14 days

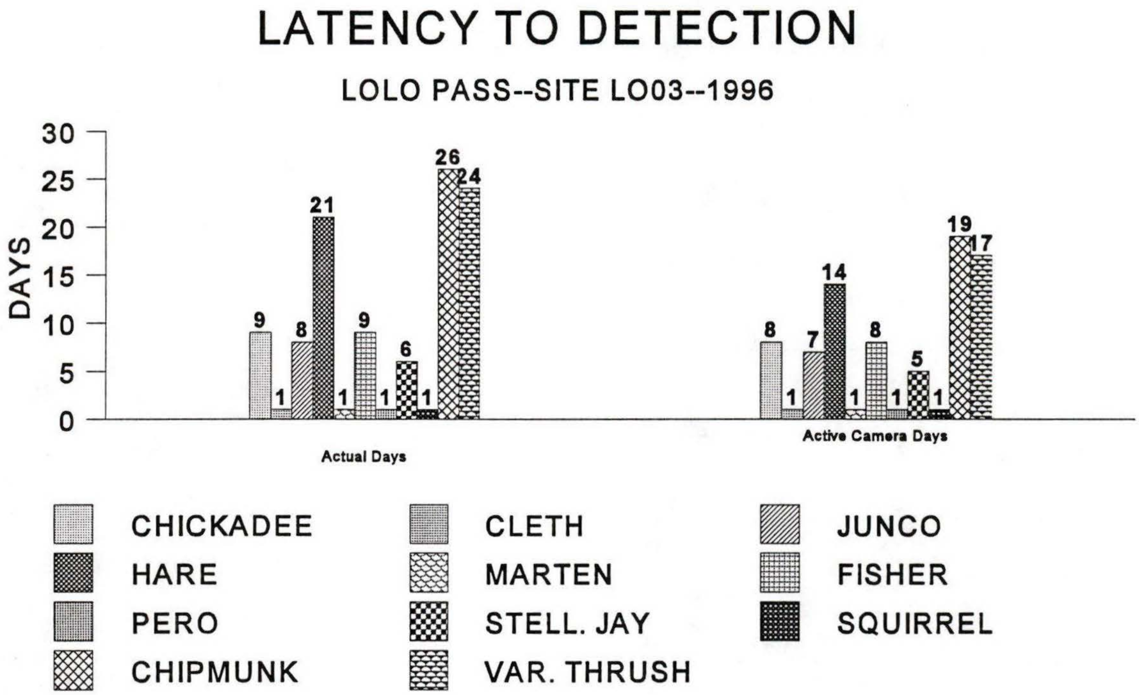
Camera station Lo02 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
1265	300	77(25%)	14(5%)	0(0%)	151(49%)	22 (7%))	36(12%)

Mean time intervals: MAAM to MAPE = 5:06 (S.D. = 1:20, n = 5)
MAPE to MAAM = 21:05 (S.D. = 30:26, n = 4)

Site: Lo03 Section: #25 Township/Range: T.11N.R.24W.

Site employed a baited TM 500 camera system set to detect small mammal species. On 05MAR96, a partially consumed snowshoe hare was discovered in the drainage approximately one third of a mile north of U.S. Highway 12 (UTM 686420 x 5172460). The hare remains were fresh. Tracks and sign suggested a marten killed the hare in a tree well, then drug the carcass to the top of a snow covered root wad where it consumed much of the entrails, neck and forelegs.



A tree well within 5 m of the feeding site was chosen for the camera station. The set was baited with rolled oats, peanut butter, and commercial mustelid lure. Habitat variables were not recorded at this site due to field technician injury. Snow conditions at set initiation: approximately two meters of snow with a thick crust and 2-3" of surface powder. Tracks/Sign at set initiation: Pine marten, snowshoe hare, red squirrel, coyote, and weasel tracks were observed in the drainage. Camera operation: Initial camera system was a Manley, which failed to operate in the field. The backup camera, also a Manley failed to operate also. One day later, a TM 500 camera system was installed which functioned properly.

Camera station Lo03 time table:

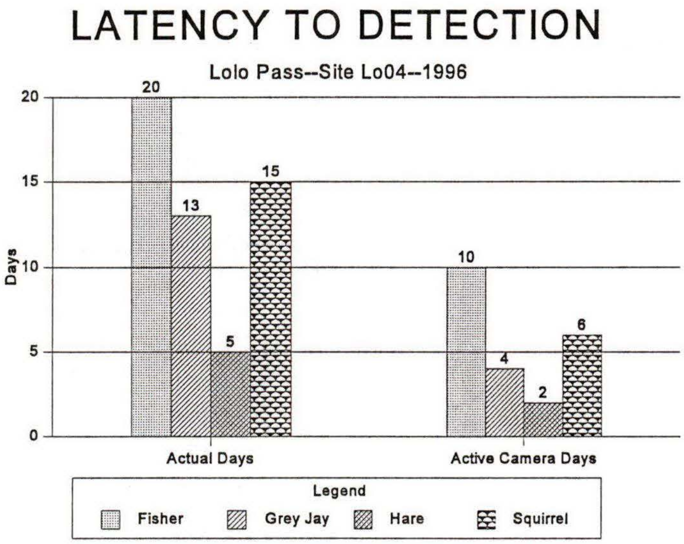
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
08MAR96-05APR96	28 days	22 days	6 days

Camera station Lo03 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
280	198	130(66%)	------	29(15%)	47(24%)	21(11%)	0(0%)

Site: Lo04 Section: #25 Township/Range: T.11N.R.24W.

Site employed a baited TM 500 camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site was located one mile north of U.S. Highway 12 (UTM 686310 x 5173460). Habitat variables were not recorded at this site due to field technician injury. Snow conditions at set initiation: approximately two meters of snow with a thick crust; no surface powder. Tracks/Sign at set initiation: bobcat tracks (*Lynx rufus*), coyote, red squirrel and snowshoe hare tracks observed in the vicinity. Camera operation: Camera functioned properly upon installation.



Camera station Lo04 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
01MAR96-05APR96	35 days	20 days	15 days

Camera station Lo04 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
331	165	1(1%)	10(6%)	25(15%)	127(76%)	20 (12%)	7 (4%)

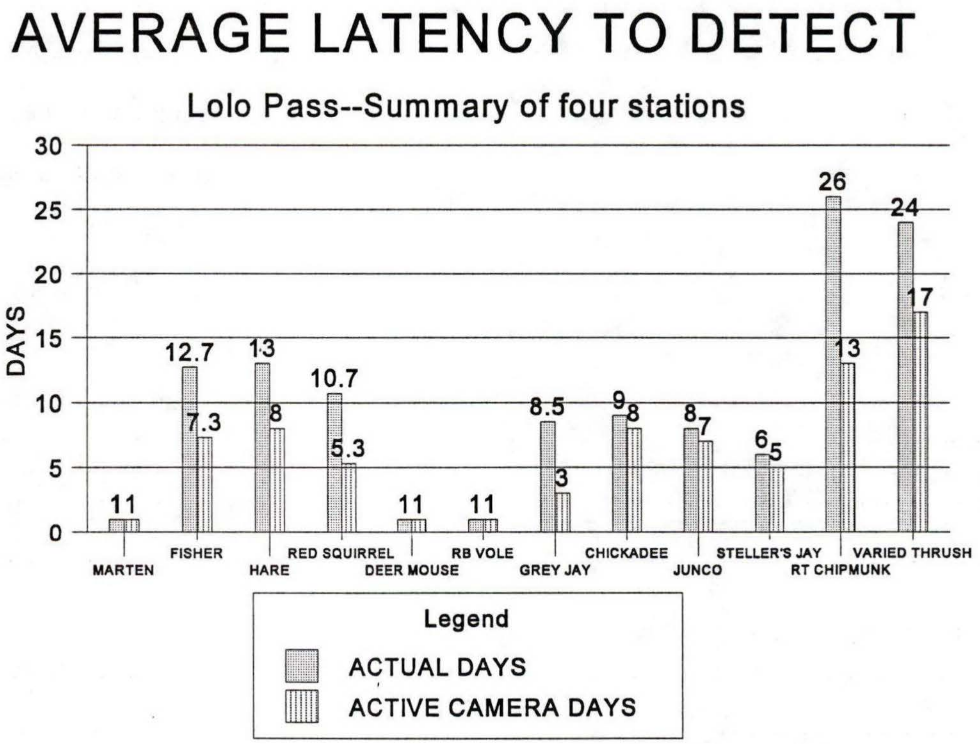
Summary of Lolo\Snowshoe Falls I Camera Survey

Survey Time Table:

	Survey Duration	Active Camera Days	Down Camera Days
Total	140	98 (70%)	42 (30%)
Mean	35.0	24.5	10.5
Stand. Dev.	5.0	4.8	4.6

Survey Photo Table:

	EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
TOTAL	1929	716	208(29%)	24 (3%)	84(12%)	339(47%)	94 (13%)	50(7%)
MEAN	482.3	184.8	27.0	6.0	21.0	84.8	23.5	12.5
ST. DEV.	535.6	105.2	36.1	7.1	14.2	64.2	5.1	16.0



Second Suite of Cameras

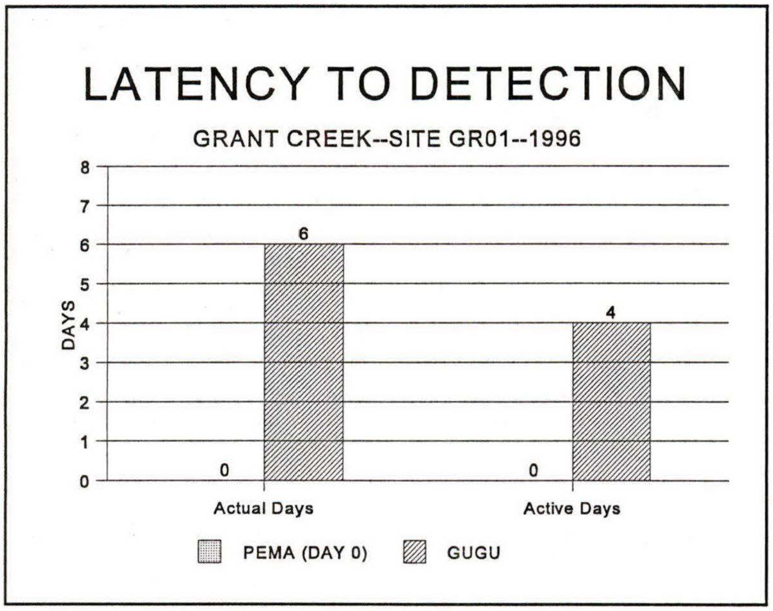
One of the four target species was recorded with the second suite of cameras: a wolverine (*Gulo gulo*) was observed in the Grant Creek Study Area. Non-target species and small mammal species detected included mountain lion, red squirrel, deer mice, red-backed vole, snowshoe hare, bobcat , bushy tailed woodrat (*Neotoma cinerea*), short-tailed weasel and possibly a shrew (*Sorex* spp.).

Camera Station Descriptions

Grant Creek Study Area

Site: Gr01 Section: 35 Township/Range: T15N,R19W

Site employed a baited TM 500 camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site was located along east side of Grant Creek on a small glacial moraine (UTM 274066 x 5210039). Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax.* Co-dominant cover species was lodgepole pine and Douglas fir. Overstory age class was Medium I to Medium II (9"-21" dbh). Course woody debris estimated at 11 tons\hectare. Stand vertical structure evaluated as young forest multi-strata. Distance to water: 40 m; squirrel midden: NA; trail: approximately 150 m. Camera operation: Camera system functioned properly upon installation.



Camera station Gr01 time table:

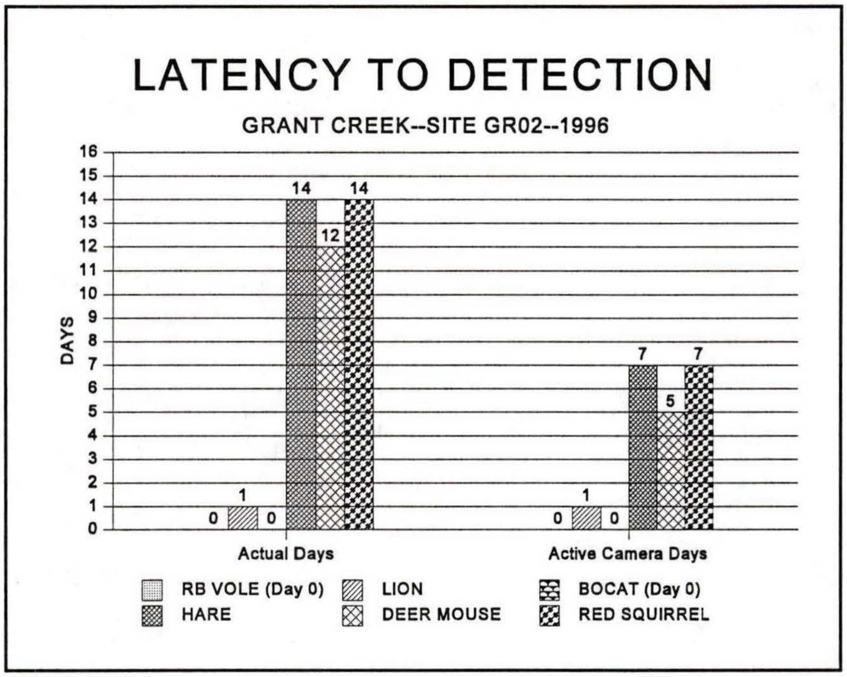
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
17APR96-09MAY96	22 days	11 days	11 days

Camera station Gr01 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
-----	166	1 (1%)	41(25%)	114(69%)	113(68%)	11 (7%)	0 (0%)

Site: Gr02 Section: 35 Township/Range: T15N,R19W

Site employed a baited TM 500 camera system set to survey small mammal presence. Station was baited with peanut butter, rolled oats, and a mixture of fish, fish oil, peanut butter and oats rolled into a ball. Site was located along east side of Grant Creek (UTM 273576 x 5216050). Habitat type keyed to *Abies grandis/Clintonia uniflora.* Dominant cover species was western larch and Douglas fir. Overstory age class was Medium II to Large (>15" dbh). Course woody debris estimated at 11 tons\hectare. Stand vertical structure evaluated as between an old forest single-stratum and understory reinitiation (western larch comprised the old forest single-stratum and the Douglas fir coming up represented the understory reinitiation). Distance to water: 35 m; squirrel midden: 1 m; trail: approximately 55 m. One western larch snag within 15 m radius (approximately 48" dbh). Camera operation: Camera system functioned properly upon installation.



Camera station Gr02 time table:

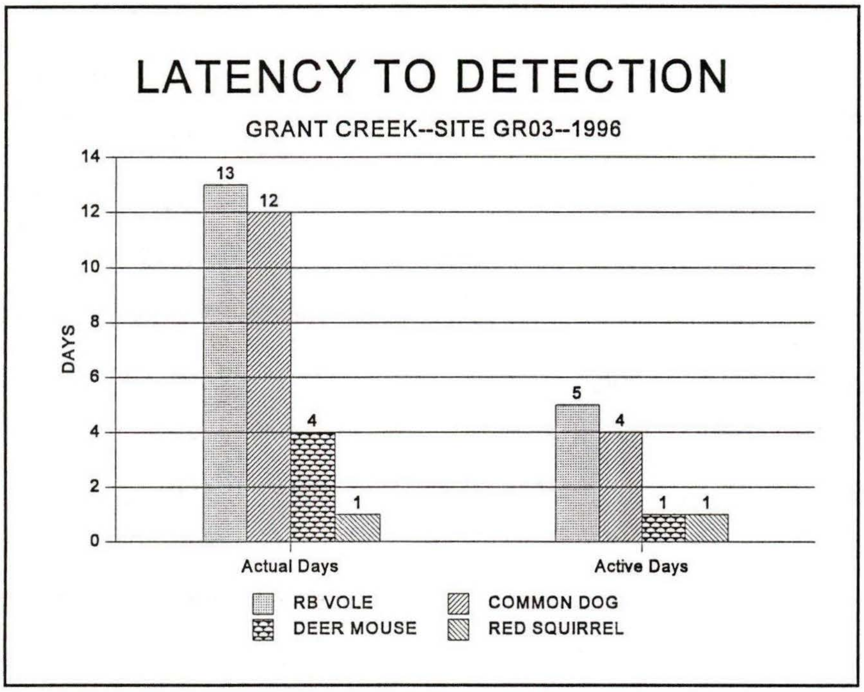
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
17APR96-05MAY96	18 days	11 days	7 days

Camera station Gr02 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
-----	138	76 (55%)	------	43(31%)	55(40%)	5 (4%)	2 (1%)

Site: Gr03 Section: 3 Township/Range: T14N,R19W

Site employed a baited TM 500 camera system set to survey small mammal presence. Station was baited with peanut butter and rolled oats. Site was located along east side of Grant Creek (UTM 273368 x 5209495). Habitat type keyed to *Abies grandis/Xerophyllum tenax*. Dominant cover species was Douglas fir. Overstory age class was Medium I to Medium II (9"-21" dbh). Course woody debris estimated at 9 tons\hectare. Stand vertical structure evaluated as young forest multi-strata. Distance to water: 29 m; squirrel midden: 4 m; trail: approximately 40 m. One Douglas fir snag within 15 m radius (10" dbh). Camera operation: Camera system functioned properly upon installation.



Camera station Gr03 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
17APR96-08MAY96	21 days	5 days	16 days

Camera station Gr03 photo table:

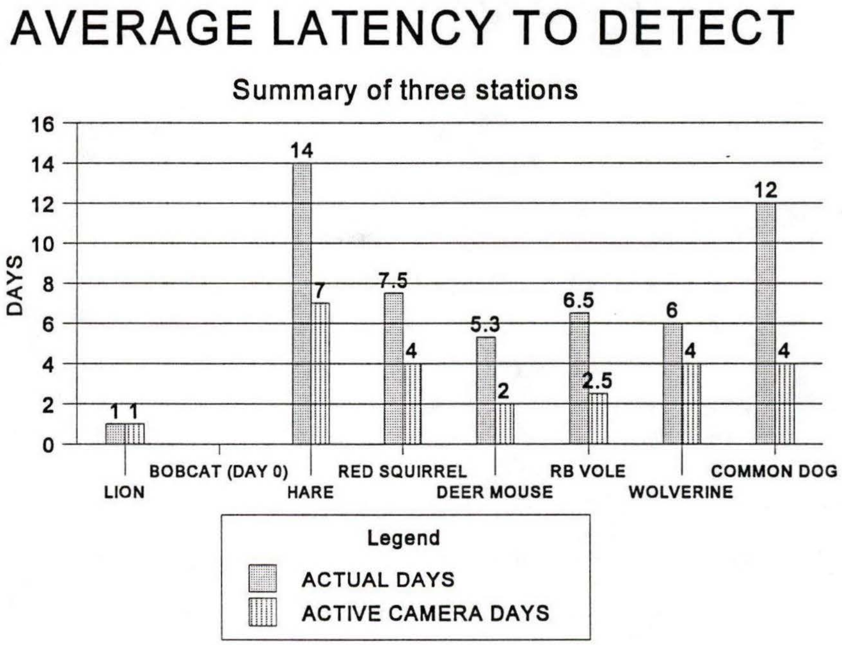
EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
-----	142	71 (50%)	------	0(0%)	66(46%)	5(4%)	0 (0%)

Summary of Grant Creek Camera Survey

Summary Time Table:

	Survey Duration	Active Camera Days	Down Camera Days
Total	61	27 (44%)	34(56%)
Mean	20.3	9.0	11.3
Stand. Dev.	2.1	3.5	4.5

Figure 13. Average latency to detection for the Grant Creek Study Area.



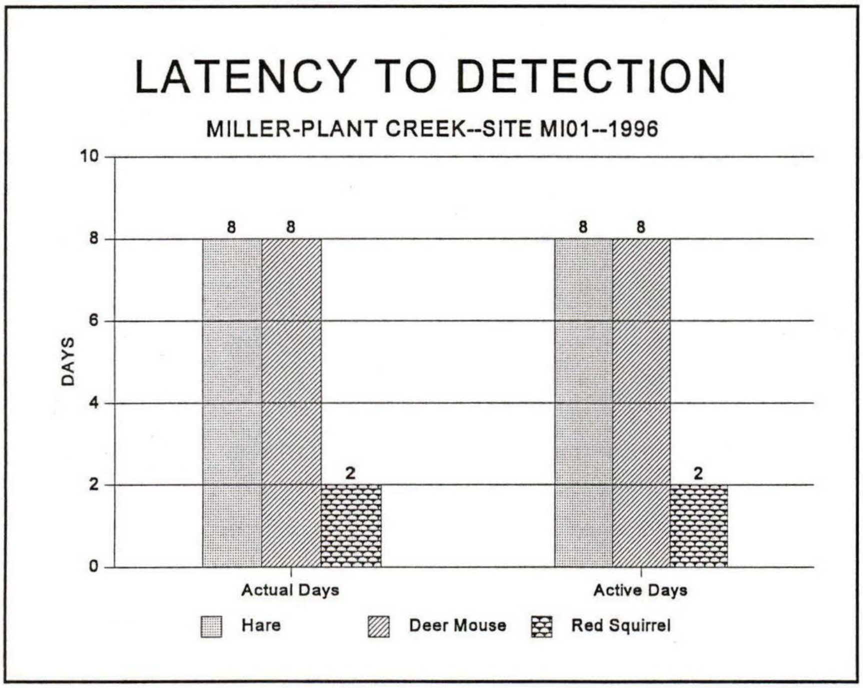
Carnivore and Blind Sets Photo Table:

	EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
TOTAL	----	446	148(33%)	41 (9%)	157(35%)	234(52%)	21 (5%)	2(<1%)
MEAN	-----	148.7	49.3	13.7	52.3	78.0	7.0	0.7
ST. DEV.	-----	15.1	41.9	23.7	57.6	30.8	3.5	1.2

Miller\Plant Creek Study Area

Site: Mi01 Section: 9 Township/Range: T11N,R18W

Site employed a baited TM 500 camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site was located approximately 150 m east of road 2110 (UTM 280305 x 5178506). Most of the immediate area had been harvested. The cover at the site consisted of Engelmann spruce along a Streamside Management Zone, alder (*Alnus* spp.), mountain maple (*Acer glabrum*) and other shrubs. No coniferous trees regenerating. Course woody debris estimated at 12 tons\hectare. Distance to water: 9 m; squirrel midden: 2 m; road: approximately 150 m. Tracks/Sign at set initiation: Difficult to assess due to conditions. Elk (*Cervus elephus*), deer, and moose tracks observed in the area. Camera operation: Camera system functioned properly upon installation.



Camera station Mi01 time table:

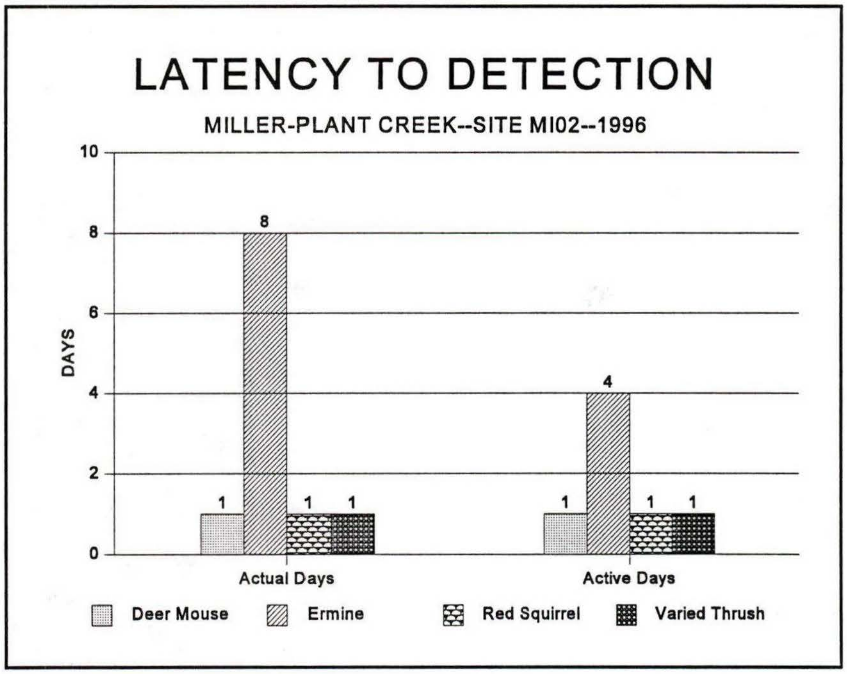
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
16APR96-02MAY96	16 days	16 days	0 days

Camera station Mi01 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
-----	38	0 (0%)	6(16%)	0(0%)	22(58%)	9 (24%)	1 (3%)

Site: Mi02 Section: 8 Township/Range: T11N,R18W

Site employed a baited TM 500 camera system set to survey the presence of small mammals. Site was located approximately 150 m west of road 2110 (UTM 280141 x 5178518).



Habitat type keyed to *Picea/Galium triflorum.* Dominant cover species was Engelmann spruce. Stand age class was Medium II to Large (>15" dbh). Course woody debris estimated at 15-20 tons\hectare. Stand vertical structure evaluated as old forest multi-strata. Distance to water: 17 m; squirrel midden: 6 m; road: approximately 150 m. Tracks/Sign at set initiation: Difficult to assess due to conditions. Elk, deer, and moose tracks observed in the area. Camera operation: Camera system functioned properly upon installation.

Camera station Mi02 time table:

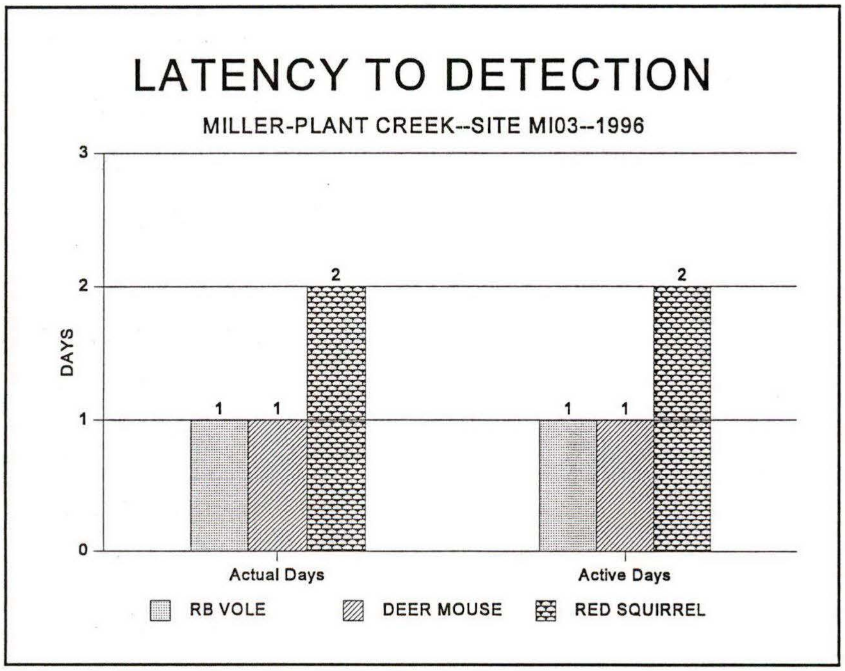
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
17APR96-02MAY96	15 days	9 days	6 days

Camera station Mi02 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
-----	114	86 (75%)	-------	1(1%)	23(20%)	4 (4%)	1 (1%)

Site: Mi03 Section: 8 Township/Range: T11N,R18W

Site employed a baited TM 500 camera system set to survey the presence of small mammals. Site was located approximately 150 m south of road 2110 (UTM 280005 x 5178620). Habitat type keyed to *Abies lasiocarpa/Linnaea borealis*. Co-dominant cover species were Douglas fir and western larch. Stand age class was Medium II to Large (>15" dbh). Course woody debris estimated at 14 tons\hectare. Stand vertical structure evaluated as old forest multi-strata. Two snags within 15 m radius: one western larch (28"dbh), one Douglas fir (40 " dbh). Distance to water: 23 m; squirrel midden: 10 m; road: approximately 150 m. Tracks/Sign at set initiation: Difficult to assess due to conditions. Elk, deer, and moose tracks observed in the area. Camera operation: Camera system functioned properly upon installation.



Camera station Mi03 time table:

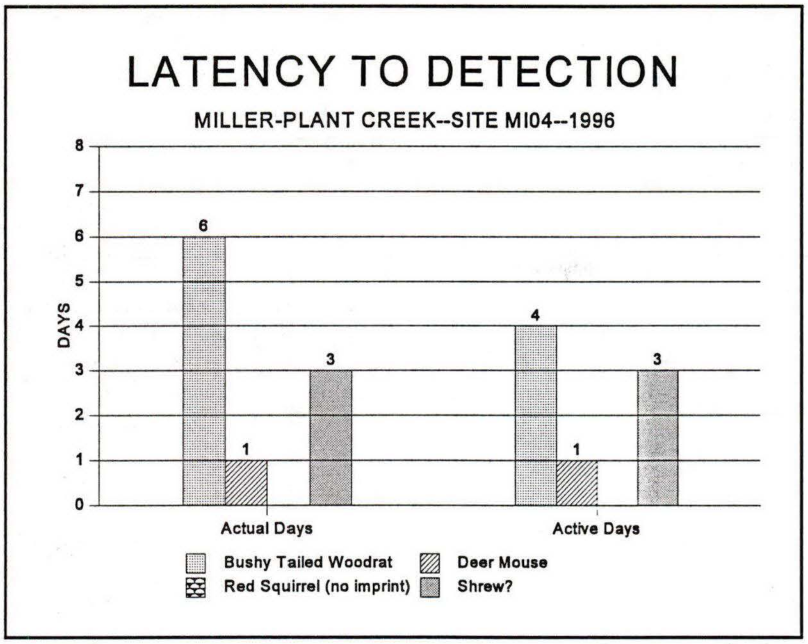
Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
17APR96-02MAY96	15 days	4 days	11 days

Camera station Mi03 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	CAMMAL
-----	116	24 (21%)	-------	1(1%)	26(22%)	2 (2%)	64 (55%)

Site: Mi04 Section: 8 Township/Range: T11N,R18W

Site employed a baited TM 500 camera system set in the fashion of Foresman and Pearson (1995) and Kucera et al. (1995). Site was located approximately 200 m from the confluence of east fork and main Plant Creek (UTM 279280 x 5178630). Habitat keyed to *Picea/Linnaea borealis*. Dominant cover type was Engelmann spruce. Age class included Medium II and Large (>15" dbh). Course woody debris estimated at 9 tons\acre. Distance to water: 1 m; squirrel midden: 19 m; road: approximately 200 m. Stand vertical structure evaluated as old forest single stratum. Tracks/Sign at set initiation: Difficult to assess due to conditions. Elk, deer, and moose tracks observed in the area. Camera operation: Camera system functioned properly upon installation.



Camera station Mi04 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
17APR96-02MAY96	15 days	13 days	2 days

Camera station Mi04 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
-----	61	0 (0%)	13(21%)	1(2%)	39(64%)	6 (10%)	3 (5%)

Summary of Miller\Plant Creek Camera Survey

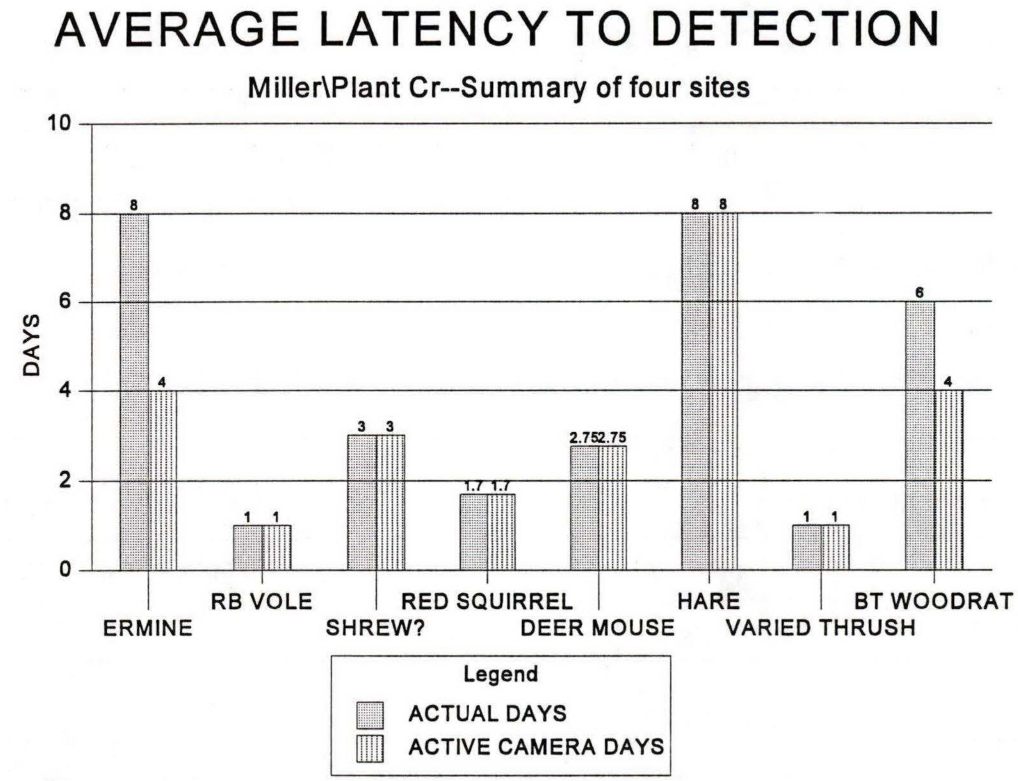
Survey Time Table:

	Survey Duration	Active Camera Days	Down Camera Days
Total	61	42 (69%)	19 (31%)
Mean	15.25	10.5	4.75
Stand. Dev.	0.5	5.2	4.9

Survey Photo Table:

	EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
TOTAL	-----	329	110(33%)	19 (6%)	3(1%)	110(33%)	21 (6%)	69(21%)
MEAN	-----	82.25	27.5	4.75	0.75	27.5	5.25	17.25
ST. DEV.	-----	39.0	40.6	6.2	0.5	7.9	3.0	31.2

Figure 17. Average latency to detection for the Miller/Plant Creek Study Area.



Third Suite of Cameras

One of the four target species was recorded with the third suite of cameras: marten. Non-target species detected included short-tailed weasel, red squirrel, varied thrush and mule deer (*Odocoileus hemionus*).

Camera Station Descriptions

Montana Border Study Area

Site: MT01 Section: 2 Township/Range: T10N,R23W

Site employed an unbaited TM 500 camera system. The camera station was design to monitor a strip of timber (UTM 695667 x 5169494) approximately 50 m wide which connected two patches of unharvested timber (both patches approximately 400 acres in size). Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax*. Co-dominant cover species were lodgepole pine, Engelmann spruce, and subalpine fir. Overstory age class included Medium I and Medium II (9"-21" dbh). Course woody debris estimate at 9 tons\acre. Distance to: water: > 1 km; squirrel midden: NA; skid road: approximately 70 m. One snag of unknown species (13" dbh) was within a 15 m radius of the set. Vertical structure was difficult to evaluate due to timber harvest activities. Timber harvest had encroached the corridor from both sides and subsequent blow down from exposure had altered the stand. Given these factors it most closely resembled an old forest multi strata. Tracks and sign at set initiation: elk and deer track in vicinity. Camera operation: Camera functioned properly upon installation.

Camera station MT01 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
15JUN96-23JUN96	8 days	8 days	0 days

Camera station MT01 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	Unknown
24	24	------	2(8%)	3(13%)	17(71%)	4 (17%)	1 (8%)

Lolo Pass\Snowshoe Falls II Study Area

Site: SS01 Section: #25 Township/Range: T.11N.R.24W.

Site employed a baited TM 500 camera system. The camera station was design to monitor a pair of baited track plates (one open plate and one closed plate). Habitat variables were not recorded at this site due to field technician injury. Tracks and sign at set initiation: elk and deer track in vicinity. Camera operation: Camera functioned properly upon installation.

Camera station SS01 time table:

Sampling Period	Sampling Duration	Active Camera Days	Down Camera Days
20AUG96-01SEP96	12 days	12 days	0 days

Camera station SS01 photo table:

EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
29	29	2 (7%)	13(45%)	0(0%)	10(34%)	3 (17%)	1 (3%)

Summary of MT Border\Snowshoe Falls II Camera Survey

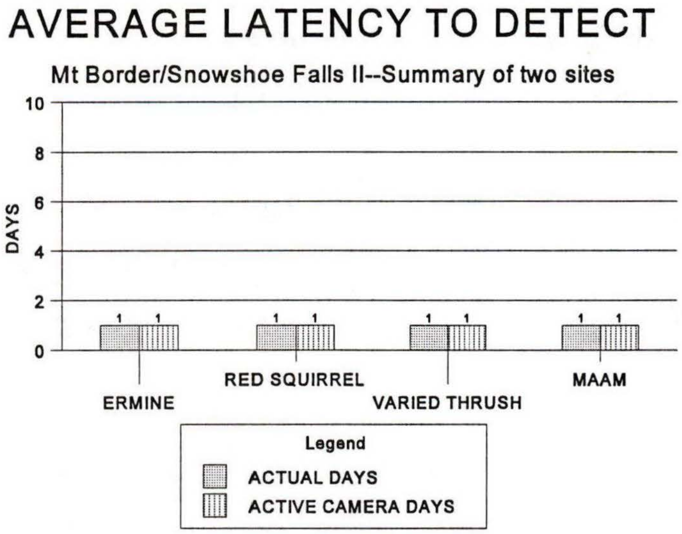
Survey Time Table:

	Survey Duration	Active Camera Days	Down Camera Days
Total	20	20 (100%)	0 (0%)
Mean	10.0	10.0	10.0
Stand. Dev.	2.8	2.8	2.8

Survey Photo Table:

	EVENTS	PHOTOS	TARGET	NONTAR	NO IMPR	NA	TEST	BD EXP
TOTAL	53	53	2(4%)	15 (28%)	3(6%)	27(51%)	7(13%)	1(2%)
MEAN	26.5	26.5	1.0	7.5	1.5	13.5	3.5	0.5
ST. DEV.	3.5	3.5	1.4	7.8	2.1	4.9	0.7	0.7

*one photo from MT Border had an unidentifiable species.



OVERALL CAMERA SURVEY SUMMARY

Overall, three of the target species were detected with remote sensing camera systems: marten, fisher, and wolverine. Marten were observed in three of the study areas, fisher in two of the study areas, and wolverine in one of the study areas. Mean latency to detection overall:

Species	Actual Days	Active Camera Days
Marten	16.0 +/- 13.3 (SD)	12.3 +/-9.5 (SD)
Fisher	10.75 +/- 6.5 (SD)	6.0 +/- 3.7 (SD)
Wolverine	6 (n = 1)	4 (n =1)

Camera System Performance

Of the 559 days that cameras were in the field, they were not monitoring bait stations (i.e. "down") 161 days (3854 hours). Causes for down time were broken into five categories:

1) Battery Dead: included cameras which were not functioning due to insufficient

amperage to fire the camera and still had film unexposed.

2) Film Spent: included cameras which had exposed all the frames on the roll of film.

3) Camera Malfunction: included down time as the result of a faulty camera unit (i.e. stuck shutters, bad contacts, etc.).

4) Sensor Malfunction: included down time as the result of a faulty sensor unit.

5) Unknown: included down time when battery, camera, sensor, and film were operative but camera failed to operate. In all of these cases, the camera system functioned properly after turning the system off and on.

The breakdown of camera downtime was as follows:

Battery Dead	Film Spent	Camera Mal.	Sensor Mal.	Unknown
1634 hours	1886 hours	98 hours	115 hours	122 hours
42.4 %	49.0%	2.5%	2.9%	3.1 %

Camera down time was dominated by two causes: dead batteries and spent film. We found that the small mammal sets tend to have much more activity than normal baited carnivore sets and subsequently more photos are taken. Therefore, it was necessary to re-visit the sites on a more frequent basis than suggested by Kucera et al. (1995) and Foresman and Pearson (1995). At some small mammal stations, a roll of new film would only last one or two nights.

Battery life was compared to the number of events recorded over the battery's life, the number of photos taken over the battery's life, the low average temperature over the battery's life, and the minimum temperature during the battery's life. Of these, only the low average temperature showed a weak correlation to battery life. Manley and TM 500 camera systems showed marked differences in how low average temperature affected battery life which may be explained by the metal box of the Manley camera system which provides some protection from the elements for the actual camera. With a TM 500, the camera is not protected at all .

Battery Life Variables from TM 500 and Manley Cameras from Lolo Pass, Bear/Burr Ridge, and Big Creek Study areas:

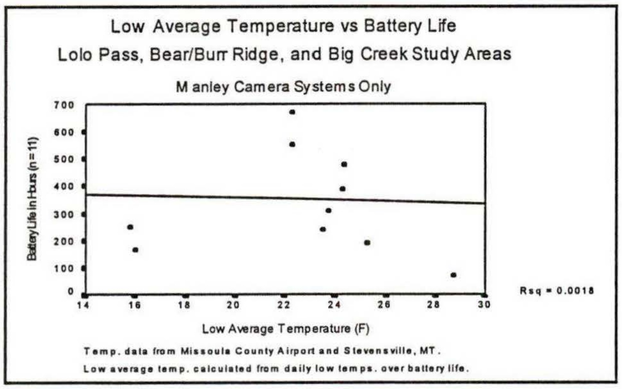
Variable	Mean	Std. Dev.	Minimum	Maximum
Battery Life (hours)	227.78	198.07	9.03	672.00
Events	83.16	186.60	2.00	1054.00
Photos	31.41	45.63	2.00	237.00
Low Average Temperature	21.95	5.03	9.00	28.75
High Average Temperature	45.14	8.11	25.00	59.00
Minimum Temperature	10.46	9.16	-3.00	28.00
Maximum Temperature	56.24	9.16	28.00	65.00

Battery Life Variables from TM 500 Camera Systems from Lolo Pass, Bear/Burr Ridge, and Big Creek Study areas:

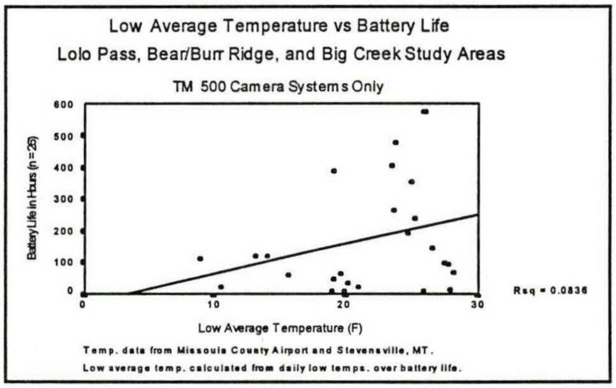
Variable	Mean	Std. Dev.	Minimum	Maximum
Battery Life (hours)	175.06	179.65	9.03	576.00
Events	111.77	217.30	4.00	1054.00
Photos	38.12	52.77	2.00	237.00
Low Average Temperature	21.67	5.51	9.00	28.25
High Average Temperature	44.45	8.60	25.00	59.00
Minimum Temperature	12.04	9.18	3.00	28.00
Maximum Temperature	53.92	9.88	28.00	65.00

Battery Life Variables from Manley Camera Systems from Lolo Pass, Bear/Burr Ridge, and Big Creek Study areas:

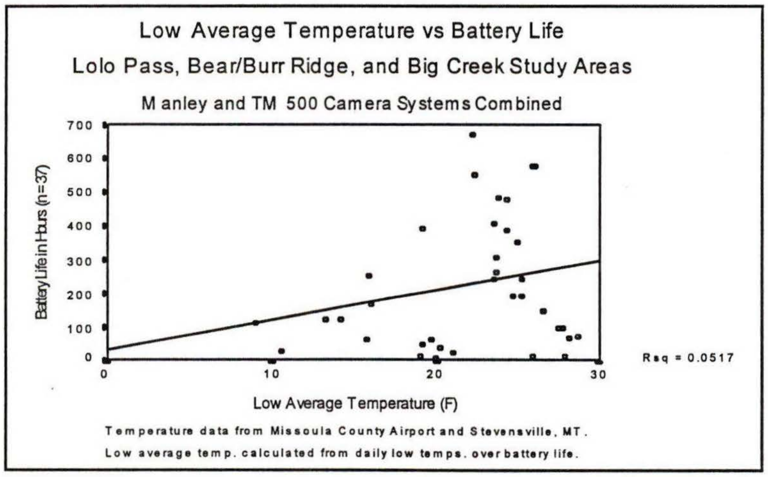
Variable	Mean	Std. Dev.	Minimum	Maximum
Battery Life (hours)	352.40	190.36	72.00	672.00
Events	15.55	11.83	2.00	37.00
Photos	15.55	11.83	2.00	37.00
Low Average Temperature	22.61	3.79	15.80	28.75
High Average Temperature	46.77	6.90	34.00	57.50
Minimum Temperature	6.73	8.34	-3.00	25.00
Maximum Temperature	61.73	3.32	53.00	65.00


Low Average Temperature vs Battery Life
Lolo Pass, Bear/Burr Ridge, and Big Creek Study Areas
Manley Camera Systems Only

Temp. data from Missoula County Airport and Stevensville, MT.
Low average temp. calculated from daily low temps. over battery life.

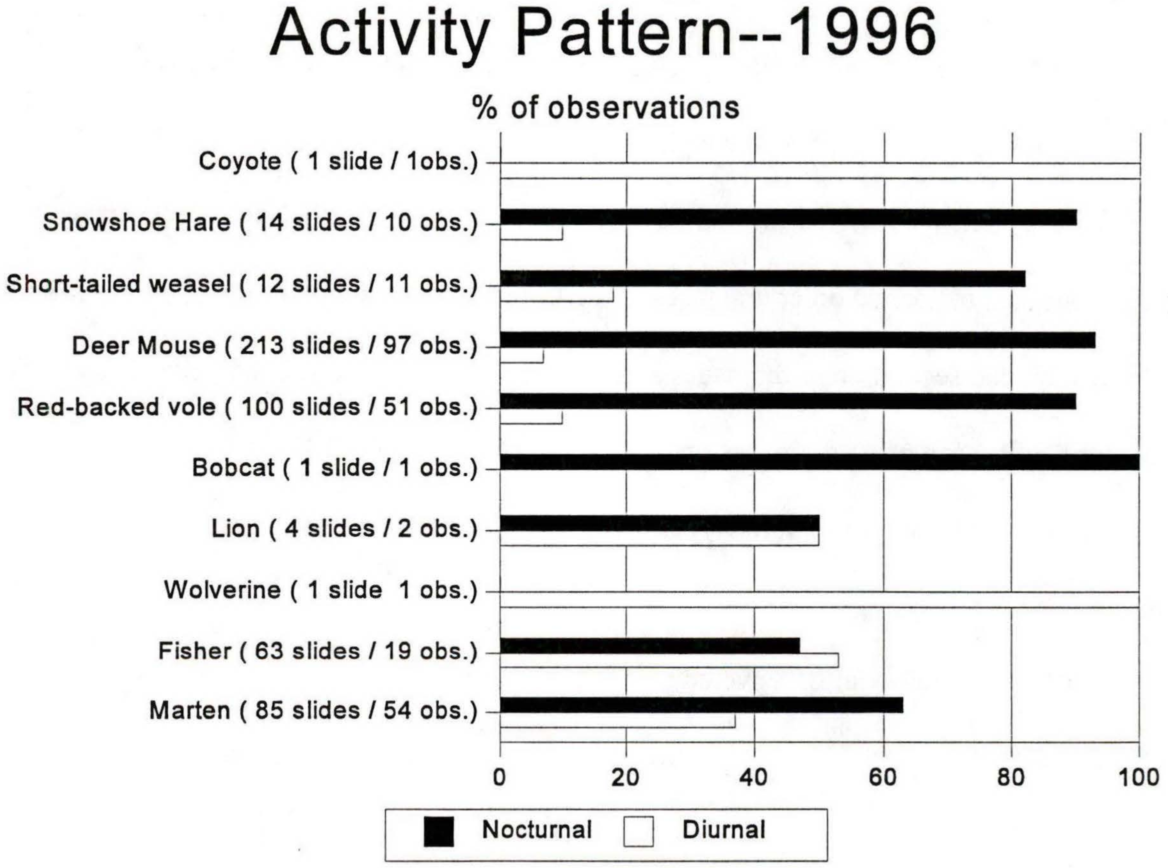

Low Average Temperature vs Battery Life
Lolo Pass, Bear/Burr Ridge, and Big Creek Study Areas
TM 500 Camera Systems Only

Temp. data from Missoula County Airport and Stevensville, MT.
Low average temp. calculated from daily low temps. over battery life.


Low Average Temperature vs Battery Life
Lolo Pass, Bear/Burr Ridge, and Big Creek Study Areas
Manley and TM 500 Camera Systems Combined

Temperature data from Missoula County Airport and Stevensville, MT.
Low average temp. calculated from daily low temps. over battery life.

In addition to survey information, the camera stations provided some data relative to activity patterns for the species detected. From the imprinted time on the slide a nocturnal or diurnal status was designated. Nocturnal time was defined as the period from one-half an hour after official sunset to one-half of an hour before official sunrise. Sunrise and sunset times for the appropriate dates were obtained from a Montana Fish Wildlife and Parks 1996 Time Table. The following chart shows the species, number of slides, number of observations (an observation defined as the occurrence of a species [one or more photograph] separated by > one hour), percent nocturnal and percent diurnal.



SECTION II: TRACKING PLATE SURVEY

Zielinski (1995) outlined techniques for detecting marten and fisher with tracking plate stations. Foresman and Pearson (1995) utilized Zielinski's design with a few modifications. In 1996, the use of tracking plate stations continued with a few modifications:

1) Foresman and Pearson (1995) varied the survey duration from 12 to 14 days. In 1996, the survey duration was restricted to 12 to 13 days.

2) Foresman and Pearson (1995) used a commercial trapping lure at all stations and re-scented the stations every fourth day. In 1996, no trapping lure was utilized.

3) Due to fire danger in 1996, the track plates were carboned at the vehicle and transported to the stations. In 1995, Foresman and Pearson (1995) carried an acetylene torch into the field and carboned the plates on-site.

4) Different terrain features and habitat types were sampled. In 1995, the survey effort was restricted to second order drainages of the Bitterroot Mountains. In 1996, the survey effort included second order drainages and ridge tops of the Bitterroot Mountains, as well as third and fourth order drainages on the Lolo Forest. Also, the 1995 survey effort included a wide variety of habitat types, from dry ponderosa pine sites to moist lower subalpine sites.

5) In 1996, the survey effort covered the winter, spring and early summer seasons. In 1996, the survey effort covered the spring , summer and early fall seasons.

METHODS

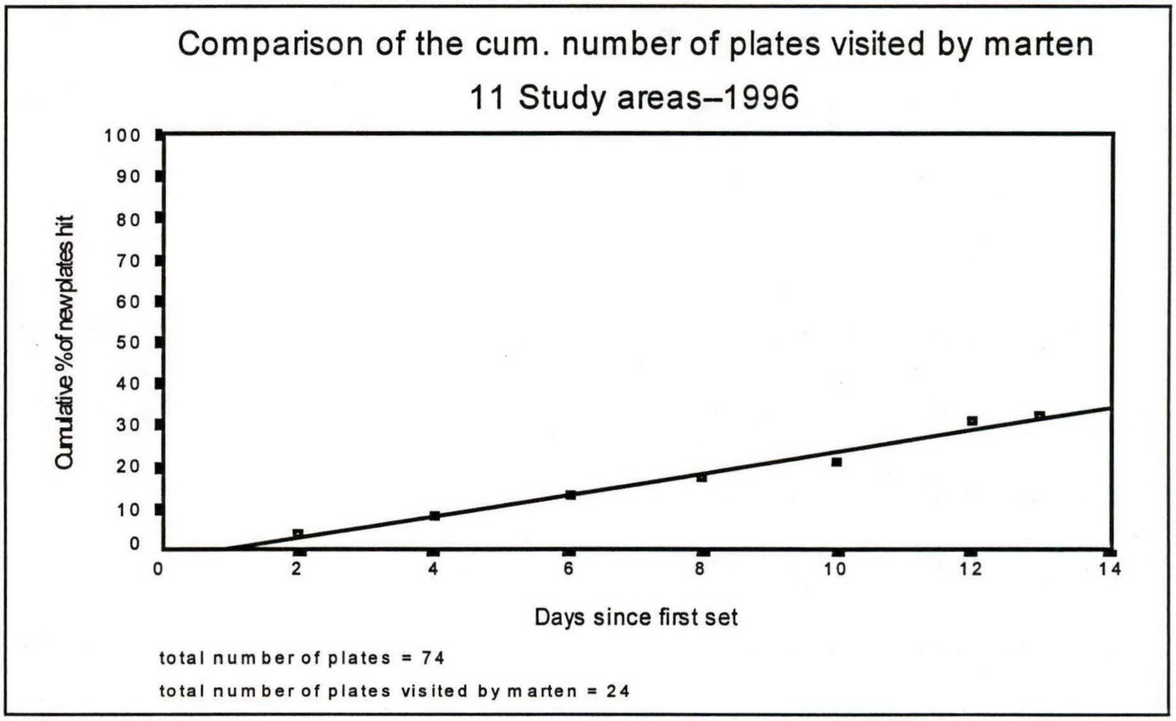
Open and closed tracking plates were utilized in the survey. Tracking plate design and use followed Zielinski (1995) and Foresman and Pearson (1995):

Tracking plate surfaces were carboned using a portable acetylene welding torch denied of oxygen to enhance carbon output. Open tracking stations consisted of two sheets of 1/16" x 16" x 28" aluminum plates placed side by side on a leveled substrate to create a 32" x 28" tracking surface. Bait (chicken parts) was placed in the center of the plates. Foreprint of target species were collected from open plates by carefully pressing a 6-8" length of clear, wide adhesive tape to the plate over a well defined print. By carefully running the tape roll back and forth over the tape and print, and leaving the ends of the tape free of carbon, a clear copy of the print could be removed from the tracking plate and affixed to a white piece of paper where it was labeled as to location, date, foot, and suspected species. Closed tracking plates utilized a 1/16" x 8" x 30" sheet of aluminum flat stock. A base was constructed of 1/32" x 12" x 30" galvanized steel flat stock with the long edges (30" sides) bent up ½" at a 90 degree angle to form a lip. A plastic hood was made from two sheets of 1/8" x 16" x 28" PVC flat stock folded side by side over the galvanized steel so that the edges tucked inside the lips of the base. Sheet metal screws were used to fasten the PVC to the base. Duct tape was used to seal the seam between the two sheets of plastic. The resulting half-cylinder box was placed on a flat surface against a log and gaps at the back of the box were filled with branches and other debris. Rocks and debris were wedged against the sides to secure the box and used as camouflage to prevent human disturbance. A sheet of white contact paper (9" x 12") was placed over the tracking plate 4" from the back of the plate. The bait (chicken parts) was placed behind the contact paper on an unblackened portion of the plate and the plate was slid into the half-cylinder box. When the contact paper was excessively marred by debris or tracks of non target species, the contact paper was changed. Contact sheets with prints of target species were collected from closed tracking plates by cutting away the folded edges and spraying the surface with Kylon Workable Fixatif Spray Coating to protect the print from smudging. After air-drying the spray coating for about 15 minutes, contact sheets were labeled and slipped into polypropylene sheet protectors. Three measurements were made on the best available print from each station. The measurements followed Zielinski and Kucera (1995): a three-variable function involving the width of the center palm pad (A), the length of the center palm pad (B), and the length of the lateral palm pad (C). The above variables were then plugged into the following equation: If $(4.595 \times A) + (3.146 \times B) + (0.906 \times C) - 80.285 > 0$, classify the track as fisher; if < 0, classify the track as marten.

Due to high forest fire potential, we did not use the acetylene torch in the forest. Instead, the plates were carboned near the vehicle where fire danger was relatively low. The carboned plates were taped to together in pairs with the blackened surfaces facing each other. The pairs of plates were then taped together to help prevent them from flexing in the backpack. When the plates flexed, the carbon tended to disintegrate. Carbon on open plates tended to deteriorate more quickly than carbon on the smaller, closed plates. This fact, and the wet weather of spring and early summer, mandated that the survey effort be heavily skewed towards closed plate stations. Tracking plate stations were checked every other day and re-baited as needed.

RESULTS

Tracking plate surveys ran from 09 May 1996 to 03 September 1996. Eleven study areas were sampled with 74 tracking plates (average number of tracking plates per study area = 6.7; min. = 4; max = 12). Tracking plate surveys were run for a minimum of 12 days resulting in 888 track-plate days. Of the four target species, only marten were detected using tracking plate stations. Marten appeared in five of the 11 study areas and were detected 24 times overall. Mean latency to detection for marten using tracking stations was 5.8. The cumulative number of new plates visited by marten within a study area varied. No study area had all plates visited by marten. Two study areas only had one plate hit by marten. The following graph describes the overall cumulative percent of plates visited by marten for all 11 study areas.



Eight other species were recorded at tracking stations: bushy-tailed woodrat (*Neotoma cinerea*), red squirrel, deer mice, striped skunk (*Mephites mephites*), black bear (*Ursus americanus*), pika (*Ochotona princeps*), short-tailed weasel, and long-tailed weasel (*Mustela *frenata*).

Discriminant scores were calculated for 17 of the track samples collected. Seven sets of tracks from open plates were not of high enough quality to obtain accurate measurement data. All 17 measured were categorized as marten. The mean discriminant scores was -12.65 (std. dev. = 5.59).

A	B	C	Discriminant Score
9.25	7.79	5.29	-8.20
8.60	7.50	7.45	-10.20
10.50	7.26	5.34	-4.10
8.71	6.68	3.74	-15.60
9.62	7.40	5.91	-7.16
8.36	7.49	5.42	-13.10
6.86	6.33	5.18	-23.90
9.33	7.65	5.68	-8.86
8.30	8.02	5.20	-11.90
8.93	7.02	6.57	-10.90
8.10	7.10	5.48	-15.50
9.57	7.46	6.55	-6.62
8.85	6.50	5.32	-14.10
8.59	6.29	4.89	-16.30
8.37	5.56	4.08	-20.35
10.28	6.33	6.13	-7.29

	7.74	6.25	4.43	-21.04
Mean	8.82	6.98	5.45	-12.65
Std. Dev.	0.90	0.68	0.92	5.59
Min.	6.86	5.56	3.74	-23.90
Max.	10.50	8.02	7.45	-4.70

Tracking Plate Station Descriptions

Grant Creek Track Plate Survey

Survey Period: 09 May 96 - 25 May 96.
Survey Area: Sections #3 of Township T 14 N R 19 W. and Sections #35, and #26 of Township T. 15 N. R. 19 W.

Plate #1: UTM 273290 x 5209290. Set approximately 50 m east of trail; approximately 20 m west of Grant Creek. Habitat keyed to *Abies grandis/ Linneae borealis*. Dominant cover species was Douglas fir. Overstory age class was Medium I (9"-15" dbh) trees. Coarse woody debris estimated at 7-9 tons/acre. Distance to: water: 20 m; trail: 50 m; squirrel midden: NA. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a live Douglas fir and baited with chicken.

Plate #2: UTM 273368 x 5209495. Set approximately 60 m east of trail; approximately 20 m above creek bottom on a small moraine. Habitat keyed to *Abies grandis/ Xerophyllum tenax*. Dominant cover species was Douglas fir. Overstory age class was Medium I and Medium II (9"-21" dbh). Coarse woody debris estimated at 9 tons/acre. Distance to: water: 20 m; squirrel midden: 4 m; trail: 60 m. One Douglas fir snag (10" dbh) within 15 m radius of set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a boulder and baited with chicken.

Plate #3: UTM 273576 x 5216050. Approximately 20 m east of trail; approximately 10 m west of Grant Creek. Habitat keyed to *Abies grandis/ Clintonia uniflora*. Co-dominant cover species were western larch and Douglas fir. Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 11 tons/acre. Distance to: water: 10 m; squirrel midden: 1 m; trail: 20m. One western larch snag (approximately 48" dbh) within 15 m radius of the set. Stand vertical structure evaluated as midway between understory reinitiation and old forest multi story. Covered plate set against a downed log and baited with chicken.

Plate #4: UTM 274066 x 5210039. Approximately 100 m east of trail; approximately 40 m east of Grant Creek. Habitat keyed to *Abies lasiocarpa/Xerophyllum tenax*. Co-dominant cover species were lodgepole pine and Douglas fir. Overstory age class was Medium I and Medium II (9"-15" dbh). Coarse woody debris estimated at 11 tons/acre. Distance to: water: 40; squirrel midden: NA; trail: 20 m. Nearest snag was 75 m (western larch; 32" dbh). Stand vertical structure evaluated as young multi-strata. Covered plate set against a downed log and baited with chicken.

Plate #5: UTM 274188 x 5210735. Approximately 50 m west of trail; approximately 4 m west of Grant Creek. Habitat keyed to *Abies lasiocarpa/ Xerophyllum tenax*. Cover species were western larch (80%), Douglas fir (10%), and Engelmann spruce (10%). Overstory age class was Large (>21" dbh). Coarse woody debris estimated at 20 tons/acre (extensive wind damage on the site). Distance to: water: 4 m; squirrel midden: 2 m; trail: 50 m. One snag of unknown species (30" dbh) within 15 m radius. Stand vertical structure evaluated as understory reinitiation. Covered plate set against a downed log and baited with chicken.

Plate #6: UTM 274469 x 5211328. Approximately 40 m west of trail; approximately 28 m. east of Grant Creek. Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax*. Cover species were western larch (80%) and Douglas fir (20%). Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 15 tons/acre. Distance to: water: 28 m; squirrel midden: NA; trail: 40 m. Three snags within 15 m radius of the set: two unknown species (28" and 32" dbh) and one western larch (21" dbh). Stand vertical structure evaluated as understory reinitiation. Snow up to one meter deep with occasional snowfree areas. Covered plate set against a broken top snag and baited with chicken.

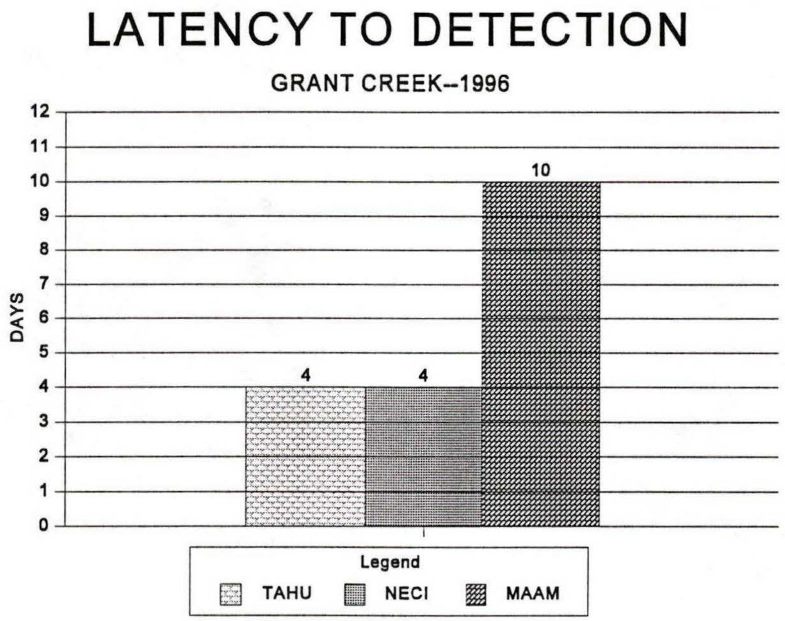
Plate #7: UTM 274664 x 5211463. Approximately 19 m west of trail; approximately 38 m east of Grant Creek. Dog hair stand of lodgepole pine (approximately 15 year old burn). Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax*. Dominant cover species was lodgepole pine. No overstory existed. Coarse woody debris estimated at 15 tons/acre. Distance to: water: 38 m; squirrel midden: NA; trail: 19 m. Two western larch snags (20" and 24" dbh) within 15 m radius of the set. Vertical structure evaluated as stand initiation. Snow depth approximately one meter. Covered plate set against a fire-killed mature lodge pole pine and baited with chicken.

Plate #8: UTM 275016 x 5211744. Approximately 12 m east of Grant Creek. Habitat type keyed to *Abies lasiocarpa/Menziesii ferruginea.* Dominant cover species was Engelmann spruce. Overstory age class was Medium II and Large (>15"dbh). Coarse woody debris estimated at 13 tons/acre. Distance to: water: 12 m; squirrel midden: 2 m; trail: NA. One Engelmann spruce snag (16" dbh) within 15 m radius. Stand vertical structure evaluated as understory reinitiation. Snow depth over one meter. Covered plate set against a live spruce and baited with chicken.

Plate #9: UTM 5212000 x 275400. Approximately 30 m south of confluence of Grant Creek and small tributary that flows from Section 36. Habitat type keyed to *Abies lasiocarpa/Menziesii ferruginea.* Co-dominant cover species were subalpine fir and Engelmann spruce. Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 15 tons/acre. Distance to: water: 30 m; squirrel midden: NA; trail: NA. One Engelmann spruce snag (19" dbh) and one western larch snag (22" dbh) within 15 m of set. Stand vertical structure evaluated as old forest multi strata. Snow depth over one meter. Covered plate set against a live spruce fir and baited with chicken.

Table summarizes Grant Creek track plate survey results:

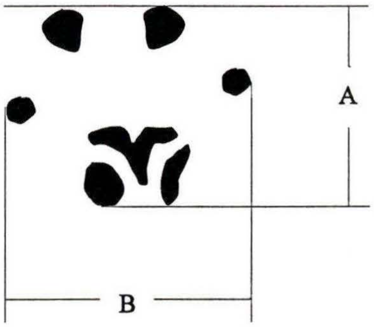
	Frequency	Percent	Cum. Percent
No Tracks	51	94.4	94.4
TAHU	1	1.8	96.2
MAAM	1	1.8	98.0
NECI	1	1.8	100.0
	-------	-------	-------
Total	54	100.0	



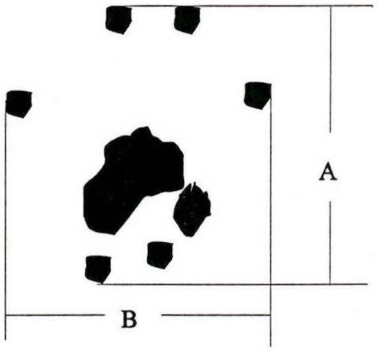
Species: *Martes americana*
Site: Grant Creek
Set #: Nine
Plate Type: Covered
Date Set: 13 May 1996
Collected: 23 May 1996
Bait: Gone
Measurements:
1) Right Forefoot: A = 9.25 mm

B = 7.79 mm
C = 5.29 mm
Discriminant Score = -8.20

Species: *Neotoma cinerea*
Site: Grant Creek
Set #: Two
Plate Type: Covered
Date Set: 09 May 1996
Collected: 13 May 1996
Bait: Not Eaten
Measurements:
1) Forefeet: A = 14.7 mm
B = 12.8 mm



Species: *Tamiasciurus hudsonicus*
Site: Grant Creek
Set #: Three
Plate Type: Covered
Date Set: 09 May 1996
Collected: 13 May 1996
Bait: Not Eaten
Measurements:
1) Forefeet: A = 24.6 mm
B = 18.1 mm



Plant Creek Track Plate Survey

Survey Period: 10 May 96 - 22 May 96.
Survey Area: Sections #7, #8 and #9 of
Township T. 11 N. R. 18 W

Plate #1: UTM 279907 x 5178414. Set approximately 200 m southwest of hairpin turn of road. Habitat type keyed to *Pseudotsuga menziesii/Linnaea borealis*. Co-dominant cover species were western larch and Douglas fir. Overstory age class was predominantly Medium II (15"-21" dbh). Coarse woody debris estimated at 9 tons/acre. Distance to: water: 110 m; squirrel midden: NA; road: 200 m. Stand vertical structure evaluated as understory reinitiation. Covered plate set against a live Douglas fir and baited with a pork chop.

Plate #2: UTM 280305 x 5178506. Set approximately 175 m east of road where it crosses the east fork of Plant Creek; approximately 10 m from creek bed. Stand harvested. A few Engelmann spruce (*Picea engelmannii*) and Douglas firs left in the immediate area. Alder (*Alnus* spp.), serviceberry (*Amelanchier alnifolia*), and other shrubs in understory. Coarse woody debris estimated at 12 tons/acre. Distance to: water: 10 m; squirrel midden: 2 m; road: 175 m. Stand vertical structure evaluated as stand initiation. Covered plate set against a downed log and baited with hamburger.

Plate #3: UTM 280141 x 5178518. Approximately 125 m west of road; approximately 17 m south of creek. Habitat typed keyed to *Picea/Galium triflora*. Dominant cover species were Douglas fir and Engelmann spruce. Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 15-20 tons/acre. Distance to: water: 17 m; squirrel midden: 6 m; road: 125 m. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a downed log and baited with chicken.

Plate #4: UTM 280005 x 5178620. Approximately 200 m south of road; approximately 40 m south of creek. Habitat type keyed as *Abies lasiocarpa/Linnaea borealis*. Co-dominant cover species were Douglas fir and western larch. Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 14 tons/acre. Distance to: water: 40 m; squirrel midden: 10 m; road: 200 m. One snag (40" dbh) of unknown species and one western larch snag (28" dbh) within 15 m radius of set. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a broken-top snag and baited with chicken.

Plate #5: UTM 279675 x 5178500. Approximately 90 m south of road; approximately 6 m north of creek. Habitat type keyed to *Pseudotsuga menziesii/Linnaea borealis*. Co-dominant cover species were Engelmann spruce and Douglas fir. Overstory age class was Medium I to Large (>9" dbh--3 Large, 2 Medium II, and 8 Medium I within 15 m radius of set). Coarse woody debris estimated at 10 tons/acre. Distance to: water: 6 m; squirrel midden: 4 m; road: 90 m. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a root wad from a blown down tree and baited with chicken.

Plate #6: UTM 279620 x 5179200. Approximately 60 m east of main road; approximately 6 m. from Plant Creek. Habitat type keyed to *Picea/Linnaea borealis* (Note: No conifer regeneration along the creek; keyed to *Picea* due to presence of large, old growth trees. Midstory was *Alnus* spp. and understory was *Linnaea borealis.*) Overstory age class was Large (>21" dbh). Coarse woody debris estimated at 9 tons/acre. Distance to: water: 6 m; squirrel midden: 1 m; road: 60 m. Stand vertical structure evaluated as old forest single stratum. Covered plate set against a downed log and baited with chicken.

Plate #7: UTM 279200 x 5178620. Habitat type keyed to *Picea/Linnaea borealis* (Note: No conifer regeneration along the creek; keyed to *Picea* due to presence of large, old growth trees. Midstory was *Alnus* spp. and understory was *Linnaea borealis.*) Overstory age class was Large (>21" dbh). Coarse woody debris estimated at 9 tons/acre. Distance to: water: 1 m; squirrel midden: 19 m; road: 80 m. Stand vertical structure evaluated as old forest single stratum. Covered plate set against a downed log.

Plate #8: UTM 278866 x 5178539 (GPS coords. taken approximately 65 m north west of set). Approximately 65 m southeast of road; approximately 21 m south of Plant Creek. Habitat type keyed to *Picea/Linnaea borealis* (Note: No conifer regeneration along the creek; keyed to *Picea* due to presence of large, old growth trees. Midstory was *Alnus* spp. and understory was *Linnaea borealis.*) Overstory age class was Large (>21" dbh). Coarse woody debris estimated at 16 tons/acre. One snag of unknown species (27" dbh) within 15 m radius of set. Distance to: water: 21 m; squirrel midden: 6 m; road: 65 m. Stand vertical structure evaluated as old forest single stratum. Covered plate set against a large broken-top snag and baited with chicken.

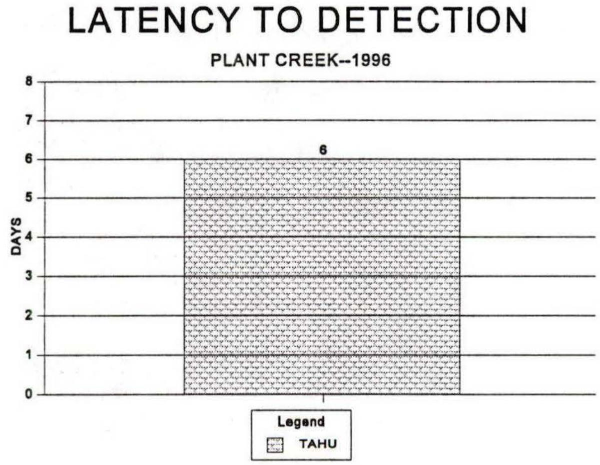
Plate #9: UTM 278700 x 5178440. Approximately 40 m southeast of road; approximately 8 m from Plant Creek. Habitat type keyed to *Picea/Linnaea borealis* (Note: No conifer regeneration along the creek; keyed to *Picea* due to presence of large, old growth trees. Midstory was *Alnus* spp. and understory was *Linnaea borealis.*) Overstory age class was Large (>21" dbh). Coarse woody debris estimated at 6 tons/acre. Distance to: water: 8 m; squirrel midden: NA; road: 40

m. Stand vertical structure evaluated as old forest multi stratum. Covered plate set against a live Engelmann spruce fir and baited with chicken.

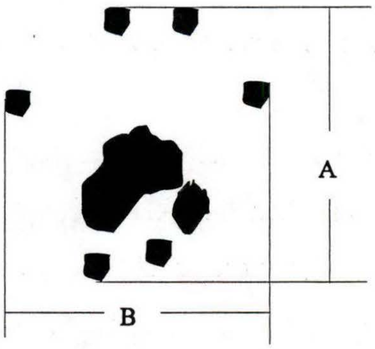
Plate #10: UTM 278440 x 5178180. Approximately 60 m southeast of road; approximately 3 m from Plant Creek. Habitat type keyed to *Pseudotsuga menziesii*. Co-dominant cover species were Engelmann spruce and Douglas fir. Overstory age class was Medium II (12"-21" dbh). Coarse woody debris estimated at 11 tons/acre. Distance to: water: 3 m; squirrel midden: NA; road: 60 m. Stand vertical structure evaluated between young and old forest multi strata. Covered plate set against a live Douglas fir and baited with chicken.

Table summarizes Plant Creek track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	59	98.3	98.3
TAHU	1	1.7	100.0
	-----	-------	---------
Total	60	100.0	



Species: *Tamiasciurus hudsonicus*
Site: Grant Creek
Set #: Three
Plate Type: Covered
Date Set: 09 May 1996



Collected: 13 May 1996
Bait: Not Eaten
Measurements:
1) Forefeet: A = 19.7 mm
B = 17.9 mm

Burdette Creek Track Plate Survey

Survey Period: 12 June 96 - 24 June 96.
Survey Area: Sections #3 and #4 Township T 12 N R 24 W.

Plate #1: UTM 681560 x 5187212. Approximately 30 m west of trail; approximately 100 m west of Burdette Creek. Habitat type keyed to *Pseudotsuga menziesii/Calamagrostis rubescens*. Dominant cover species were Douglas fir (60%) and ponderosa pine (40%). Overstory age class was large (>21: dbh). Coarse woody debris estimated at 18 tons/acre (extensive blown down trees on site). Distance to: water: 100 m; squirrel midden: NA; trail: 30 m. One snag of unknown species (19" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a live Douglas fir and baited with chicken.

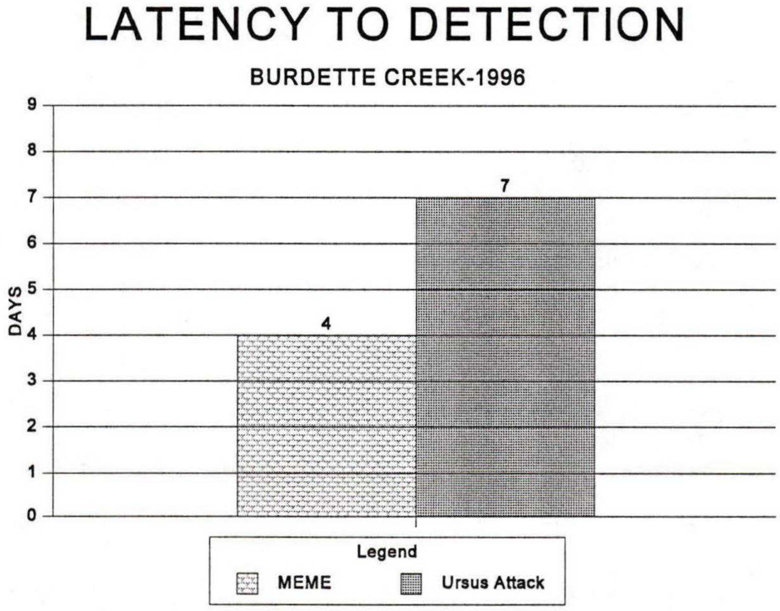
Plate #2: UTM 682018 x 5188030. Approximately 10 m west of trail; approximately 100 m west of Burdette Creek. Habitat type keyed to *Abies grandis/Linnaea borealis*. Dominant cover species was Douglas fir. Overstory age class was Large (>21" dbh). Coarse woody debris estimated at 25 tons/acre (extensive blown down trees on site). Distance to: water: 100; squirrel midden: NA; trail: 10 m. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a live lodgepole pine and baited with chicken.

Plate #3: UTM 682534 x 5188724. Set approximately 8 m west of Burdette Creek. Habitat type keyed to *Pseudotsuga menziesii/Vaccinium caespitosum*. Dominant cover species were evenly mixed ponderosa pine, western larch, and lodgepole pine. Overstory age class was Pole to Medium I (5"-15" dbh). Coarse woody debris estimated at 7 tons/acre. Distance to: water: 8 m; squirrel midden: NA; trail: 36 m. One ponderosa pine snag (23" dbh) within 15 m radius of set. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a downed log and baited with chicken.

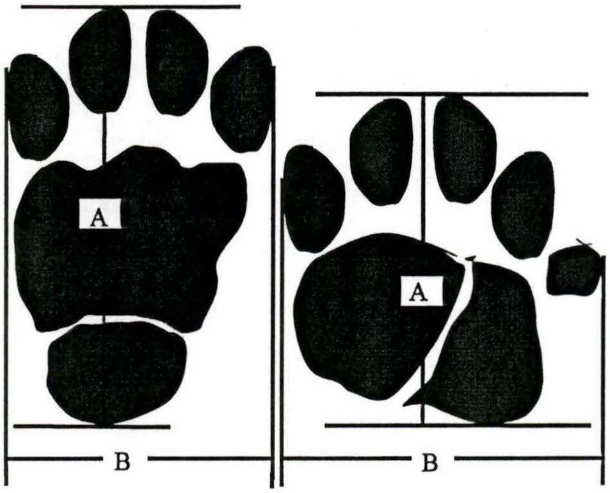
Plate #4: UTM 682705 x 5188822. Set approximately 50 m north of eastern tributary of Burdette Creek in Section #3. Habitat type keyed to *Pseudotsuga menziesii/Symphocarpos albus*. Dominant cover species was lodgepole pine. Overstory age class was Medium I (9"-15" dbh). Coarse woody debris estimated at 6 tons/acre. Distance to: water: 50; squirrel midden: NA; trail: 100 m. One lodgepole pine snag (13" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a downed log and baited with chicken.

Table summarizes Burdette Creek track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	20	83.3	83.3
Ursus Attack	2	8.3	91.7
MEME	2	8.3	100.0
	-------	-------	-------
Total	24	100.0	



Species: *Mephites mephites*
Site: Burdette Creek
Set #: Two
Plate Type: Covered
Date Set: 12 June 1996
Collected: 16 June 1996
Bait: Not Eaten
Measurements:
1) Fore Feet: A = 26.2 mm
B = 26.3 mm
Hind Foot: A = 40.1 mm
B = 25.6 mm



Species: *Mephites mephites*
Site: Burdette Creek
Set #: Two
Plate Type: Covered
Date Set: 12 June 1996
Collected: 19 June 1996
Bait: Gone
Measurements:
1) Fore Feet: A = 22.8 mm
B = 24.2 mm
Hind Foot: A = na
B = na

Upper Lost Park Track Plate Survey

Survey Period: 11 June 96 - 23 June 96.
Survey Area: Section #4 of Township T. 10 N. R. 23 W.

Plate #1: UTM 692368 x 5170326 (GPS from road--125 m north of set due to poor GPS location under canopy). Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax*. Dominant cover species were lodgepole pine and western larch. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated at 15 tons/acre. Distance to: water: NA; squirrel midden: 2 m; road: 125 m. Two lodgepole pine snags (11" and 15" dbh) and one western larch snag (23" dbh) within 15 m radius of the set. Vertical structure evaluated as young forest multi strata. Covered plate set against a downed log and baited with hamburger.

Plate #2: No UTM--Poor GPS Coverage. Habitat type keyed to *Abies lasiocarpa/Alnus sinuata.*

Dominant cover species were Engelmann spruce, lodgepole pine, and western larch. Overstory age class was Medium II to Large (>15" dbh). Coarse woody debris estimated at 12 tons/acre. Distance to: water: 30; squirrel midden: 8 m; road: 150 m. One western larch snag (28" dbh) within 15 m radius of the set. Vertical structure evaluated as old forest multi strata. Covered plate set against a live spruce and baited with hamburger and chicken.

Plate #3: UTM 691784 x 5168937. Habitat type keyed to *Abies lasiocarpa/Alnus sinuata*. Dominant cover species was Engelmann spruce. Overstory age class was Medium II to Large (>15" dbh). Coarse woody debris estimated at 12 tons/acre. Distance to: water: 35; squirrel midden: NA; road: 65 m. One western larch snag (23" dbh) within 15 m radius of the set. Vertical structure evaluated as old forest multi strata. Covered plate set against a live spruce and baited with hamburger.

Plate #4: UTM 692000 x 5170100. Covered place set against a downed log and baited with hamburger. Habitat variables were not recorded at this site due to field technician injury.

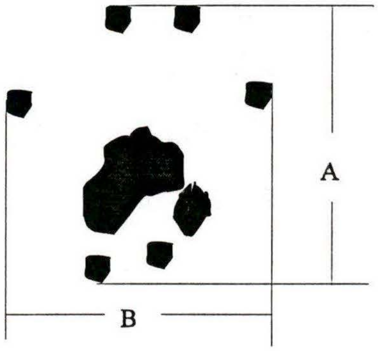
Plate #5: UTM 6924100 x 5170080. Covered place set against a downed log and baited with hamburger. Habitat variables were not recorded at this site due to field technician injury.

Table summarizes Upper Lost Park track plate survey results:

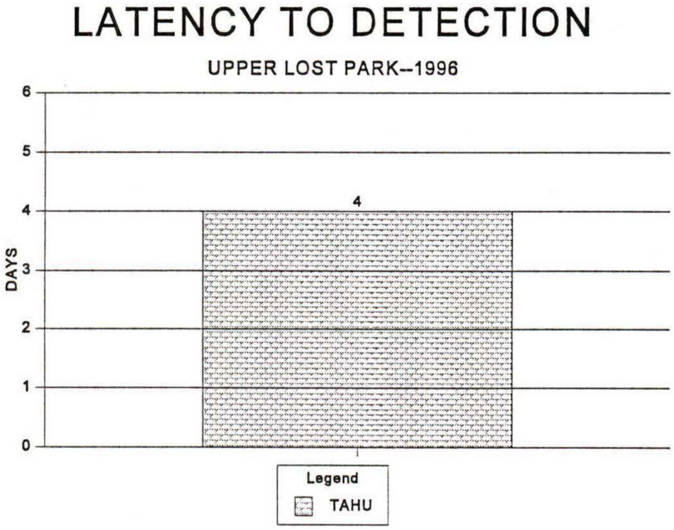
	Frequency	Percent	Cum Percent
No Tracks	27	90.0	90.0
TAHU	2	6.7	96.7
Ursus Attack	1	3.3	100.0
	-------	-------	-------
Total	30	100.0	

Note: *Martes americana* scat in front of set #3 on 17 June 1996.

Species: *Tamiasciurus hudsonicus*
Site: Lost Park
Set #: Three
Plate Type: Covered
Date Set: 11 June 1996
Collected: 15 June 1996
Bait: Bait Not Eaten
Measurements:
1) Forefeet: A = 18.4 mm
B = 14.0 mm



Species: *Tamiasciurus hudsonicus*
Site: Lost Park
Set #: Three
Plate Type: Covered
Date Set: 11 June 1996
Collected: 21 June 1996
Bait: Partially Eaten
Measurements:
1) Forefeet: A = 16.4 mm
B = 14.4 mm



Lupine Creek Track Plate Survey

Survey Period: 12 June 96 - 24 June 96.
Survey Area: Sections #11, #12, and #15 Township T 12 N R 24 W.

Plate #1: UTM 683355 x 5185862. Habitat type keyed to *Pseudotsuga menziesii/Calamagrostis rubescens*. Co-dominant cover species were ponderosa pine and Douglas fir. Overstory age class was Medium I (Douglas fir) and Medium II (ponderosa pine). Coarse woody debris estimated at <5 tons/acre. Distance to: water: 120 m; squirrel midden: 29 m; trail: 55 m. Stand vertical structure evaluated between understory reinitiation and young forest multi strata. Covered plate set against a live ponderosa pine and baited with chicken.

Plate #2: UTM 683918 x 5186197. Habitat type keyed to *Pseudotsuga menziesii/Calamagrostis rubescens.* Dominant cover species were Douglas fir (80%) and western larch (20%). Overstory age class was Medium I (Douglas fir) and Medium II (western larch). Coarse woody debris estimated at 7 tons/acre. Distance to: water: 160 m; squirrel midden: 2 m; trail: 26 m. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a downed log and baited with chicken.

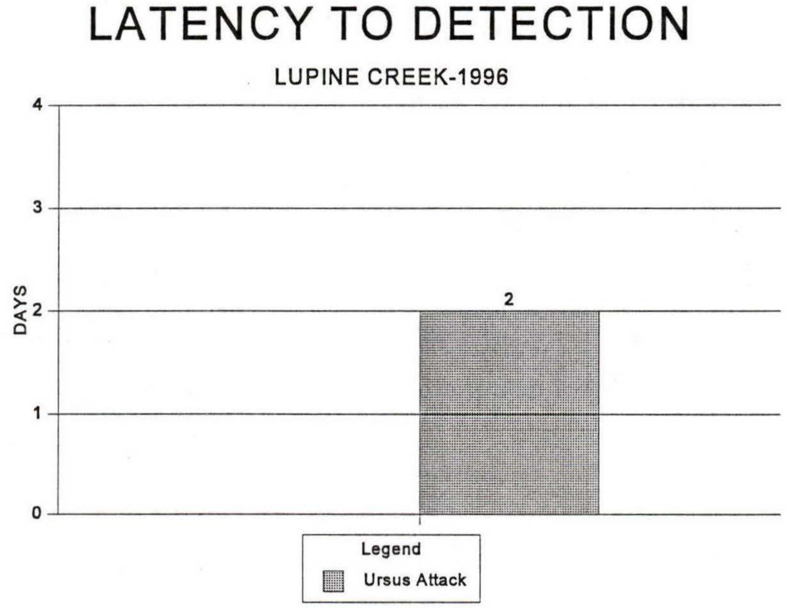
Plate #3: UTM 684564 x 5187021. Habitat type keyed to *Pseudotsuga menziesii/Calamagrostis rubescens*. Dominant cover species were Douglas fir (70%) and ponderosa pine (30%). Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at <5 tons/acre. Distance to: water: 210 m; squirrel midden: NA; trail: 60 m. One ponderosa pine snag (24" dbh) within 15 m radius of the set. Stand vertical structure evaluated between young and old forest multi strata. Covered plate set against a live Douglas fir and baited with chicken.

Plate #4: UTM 685530 x 5187007. Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax*. Dominant cover species was lodgepole pine. Overstory age class was pole (5"-9" dbh). Coarse woody debris was estimate at 14 tons/acre. Distance to: water: 16 m; squirrel midden: 3 m; trail: NA. Stand vertical structure evaluated as a closed stem exclusion. Covered plate set against a downed log and baited with chicken.

Plate #5: UTM 685593 x 5187593. Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax*. Dominant cover species was lodgepole pine. Overstory age class was pole (5"-9" dbh). Coarse woody debris was estimate at 9-10 tons/acre. Distance to: water: 20 m; squirrel midden: NA; trail: NA. One lodgepole pine snag (14" dbh) was within 15 m radius of the set. Stand vertical structure evaluated as a closed stem exclusion. Covered plate set against a downed log and baited with chicken.

Table summarizes Lupine Creek track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	24	80.0	80.0
Ursus Attack	6	20.0	100.0
	-------	-------	-------
Total	30	100.0	



Montana Border Track Plate Survey

Survey Period: 11 June 96 - 23 June 96.
Survey Area: Sections #2 and #3 of Township T. 10 N. R. 23 W.

Plate #1: UTM 694194 x 51668863. Habitat type keyed to *Abies lasiocarpa/Menziesii ferruginea*. Dominant cover species were subalpine fir and Engelmann spruce. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated at 11 tons/acre. Distance to: water: 40 m; squirrel midden: NA; road: 40 m. Three Engelmann spruce snags (12", 14" and 17" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Snow depth up to one meter; some sunlit areas snow free. Plate set against a downed log and baited with hamburger.

Plate #2: UTM 694620 x 5169180. Habitat type keyed to *Abies lasiocarpa/Menziesii ferruginea-Abies lasiocarpa/Xerophyllum tenax* (site in the transition zone between the two types). Dominant cover species were lodgepole pine, subalpine fir, and Engelmann spruce. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated at 13 tons/acre. Distance to: water: NA; squirrel midden: NA; trail: NA. Two lodgepole pine snags (14", and 16"dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Snow depth one meter with no snow free areas. Plate set against a live spruce and baited with chunks of fat and hamburger.

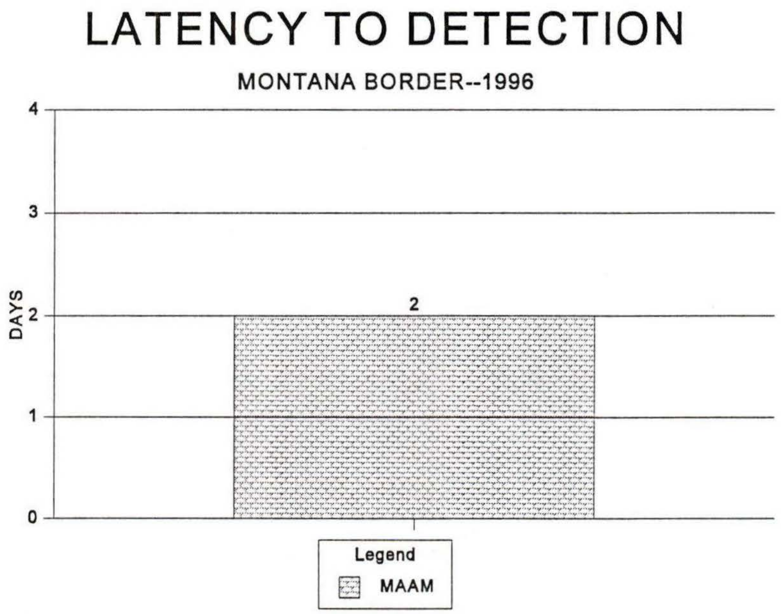
Plate #3: UTM 694720 x 5170110. Habitat type keyed to *Abies lasiocarpa/Menziesii ferruginea*. Dominant cover species was Engelmann spruce. Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 14 tons/acre. Distance to: water: 9 m; squirrel midden: NA; road: 60 m. One Engelmann spruce snag (20" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Snow depth up to one meter with no snow free areas. Plate set against a live spruce and baited with a piece of chicken.

Plate #4: UTM 695416 x 5169219. Habitat type keyed to *Abies lasiocarpa/Menziesii ferruginea*. Dominant cover species was Engelmann spruce. Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 11 tons/acre. Distance to: water: NA; squirrel midden: 8 m; trail: 75 m. One Engelmann spruce snag (17" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Snow depth one meter with no snow free areas. Plate set against a downed log and baited with hamburger.

Plate #5: UTM 693860 x 5169000. Habitat type keyed to *Abies lasiocarpa/Xerophyllum tenax*. Dominant cover species was subalpine fir (Note: area has been selectively harvested recently; mostly spruce and lodgepole pine were removed.). Overstory age class was Medium I (9"-15" dbh). Coarse woody debris estimated at 15 tons/acre. Distance to: water: NA; squirrel midden: NA; road: 150 m. One snag of unknown species (17" dbh) within 15 m radius of the set. Unable to evaluate stand vertical structure due to harvest activities. Snow depth up to one meter with many snow free areas. Plate set against a live spruce and baited with chicken.

Table summarizes Montana Border track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	27	90.0	88.0
MAAM	3	10.0	100.0
	-------	-------	-------
Total	30	100.0	



Species: *Martes americana*
Site: Montana Border
Set #: Two
Plate Type: Covered
Date Set: 11 June 1996

Collected: 13 June 1996
Bait: Partially Eaten

Measurements:
1) Left Forefoot: A = 8.66 mm
B = 7.50 mm
C = 7.45 mm
Discriminant Score = -10.2

Species: *Martes americana*
Site: Montana Border
Set #: Three
Plate Type: Covered
Date Set: 11 June 1996
Collected: 17 June 1996
Bait: Not Eaten

Measurements:
1) Right Forefoot: A = 10.5 mm
B = 7.26 mm
C = 5.34 mm
Discriminant Score = -4.10

Species: *Martes americana*
Site: Montana Border
Set #: Four
Plate Type: Covered
Date Set: 11 June 1996
Collected: 21 June 1996
Bait: Not Eaten

Measurements:
1) Right Forefoot: A = 8.71 mm
B = 6.68 mm
C = 3.74 mm
Discriminant Score = -15.6

Bear Creek Track Plate Survey

Survey Period: 07 July 96 - 20 July 96.
Survey Area: Section #12 Township T. 7 N. R. 22 W. and Section #7 T. 7 N. R. 21 W.

Plate #1: UTM 708420 x 5140160. Habitat type keyed to *Abies grandis/Linnaea borealis*.

Dominant cover species were Douglas fir and western larch. Overstory age class was Large

(>21" dbh). Coarse woody debris estimated at > 20 tons/acre (extensive blown down trees on site). Distance to: water: 10 m; squirrel midden: NA; trail: 100 m. Three Douglas fir snags (22", 19" and 17" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a down log and baited with chicken.

Plate #2: UTM 709080 x 5139950. Habitat type keyed to *Pseudotsuga menziesii/Physocarpus malvaceus*. Dominant cover species was Douglas fir. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated at <9 tons/acre. Distance to: water: 4 m; squirrel midden: 72 m; trail: 15 m. One western larch snag (26" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a live Douglas fir and baited with chicken.

Plate #3: UTM 709323 x 5140034. Habitat type keyed to *Pseudotsuga menziesii/Physocarpus malvaceus*. Co-dominant cover species were western larch and Douglas fir. Overstory age class was Medium I (9"-15" dbh). Coarse woody debris estimated at <9 tons/acre. Distance to: water: 48 m; squirrel midden: NA; trail: 20 m. One western larch snag (18" dbh), one Douglas fir snag (7" dbh) and one snag of unknown species (26" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a snag and baited with chicken.

Plate #4: UTM 710065 x 5140000. Habitat type keyed to *Abies grandis/Linnaea borealis*. Co-dominant cover species were grand fir and Douglas fir. Overstory age class was Medium II to Large (>15" dbh). Coarse woody debris estimated at 13 tons/acre. Distance to: water: 15 m; squirrel midden: 2 m; trail: 11 m. One Engelmann spruce snag (29" dbh) and one western larch snag (46" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a downed log and baited with chicken.

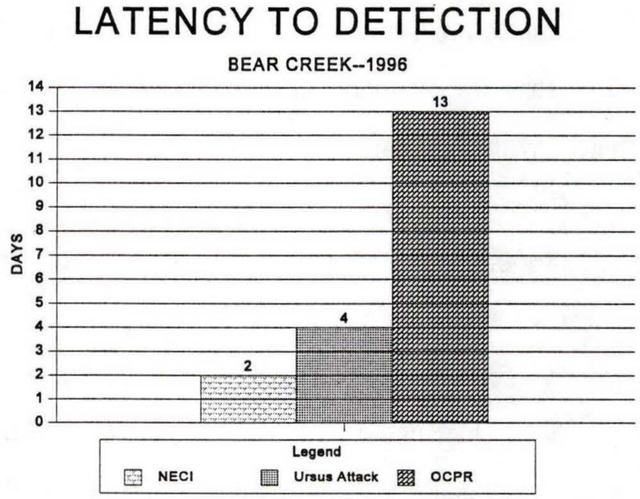
Plate #5: UTM 710580 x 5140070. Habitat type keyed to *Abies grandis/Linnaea borealis*. Co-dominant cover species were grand fir and Douglas fir. Overstory age class was Medium II

(15"-21" dbh). Coarse woody debris estimated at 9 tons/acre. Distance to: water: 9 m; squirrel midden: 16 m; trail: 120 m. One snag of unknown species (17" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a downed log and baited with chicken.

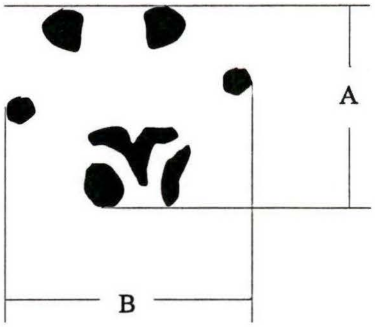
Open Plate: Located 15 m from Plate #1. Open plate set in a flat, open area and baited with chicken.

Table summarizes Bear Creek track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	33	91.7	91.7
Ursus Attack	1	2.8	94.5
NECI	1	2.8	97.3
OCPR	1	2.8	100.0
	-------	-------	-------
Total	36	100.0	



Species: *Neotoma cinerea*
Site: Bear Creek
Set #: Five
Plate Type: Covered
Date Set: 07 July 1996
Collected: 09 July 1996
Bait: Gone



Measurements:
1) Forefeet: A = 11.9 mm
B = 18.2 mm

Bear/Fred Burr Ridge Track Plate Survey

Survey Period: 07 July 96 - 20 July 96.
Survey Area: Section #13 Township T. 7 N. R. 22 W. and Section #18 T. 7 N. R. 21 W.

Plate #1: 709260 x 5138186. Habitat type keyed as *Abies lasiocarpa/ Xerophyllum tenax*. Dominant cover species was lodgepole pine. Overstory age class was Medium I (9"-15" dbh). Coarse woody debris estimated at <9 tons/acre. Distance to: water: > 1 km; squirrel midden: NA; trail: NA. Stand vertical structure evaluated as closed stem exclusion. Covered plate set against a downed log and baited with chicken.

Plate #2: UTM 709486 x 5138600. Habitat type keyed as *Abies lasiocarpa/ Xerophyllum tenax*. Dominant cover species were subalpine fir and lodgepole pine. Overstory age class was Pole (5"-9" dbh). Coarse woody debris estimated at 13 tons/acre. Distance to: water: > 1 km; squirrel midden: 40 m; trail: NA. One snag of unknown species (12" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a downed log and baited with chicken.

Plate #3: UTM 709920 x 5138568. Habitat type keyed as *Abies lasiocarpa/ Xerophyllum tenax*. Dominant cover species was subalpine fir. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated at 20 tons/acre. Distance to: water: approximately 300 m;

squirrel midden: 65 m; trail: NA. One snag of unknown species (10" dbh) within 15 m radius of the set. Stand vertical structure evaluated as between young and old forest multi strata. Covered plate set against a downed log and baited with chicken.

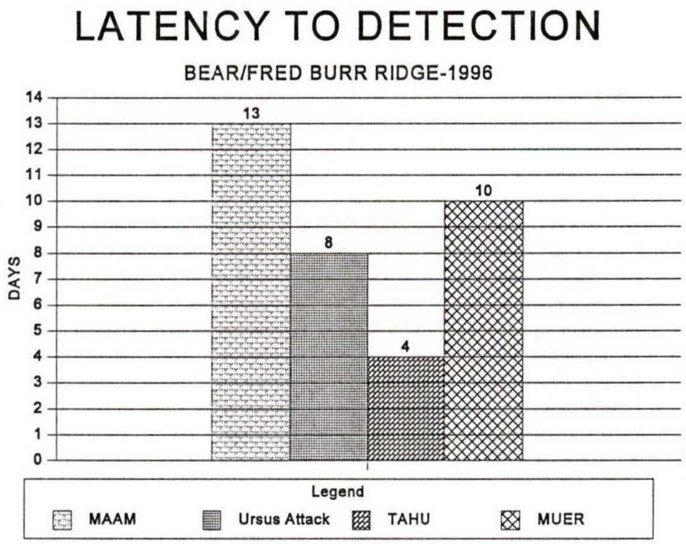
Plate #4: UTM 709750 x 5138530. Habitat type keyed as *Abies lasiocarpa/ Menziesii ferruginea*. Dominant cover species was Engelmann spruce. Overstory age class was Medium II and Large (>-21" dbh). Coarse woody debris estimated at 20 tons/acre. Distance to: water: 15 m; squirrel midden: 8 m; trail: NA. One Engelmann spruce snag (22" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Covered plate set against a root wad and baited with chicken.

Plate #5: UTM 710210 x 5138730. Habitat type keyed to *Picea/Clintonia uniflora*. Dominant cover species was Engelmann spruce. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated between 10-13 tons/acre. Distance to: water: 2 m; squirrel midden: 5 m; trail: NA. Stand vertical structure evaluated as between young and old multi strata. Covered plate set against a root wad and baited with chicken.

Open Plate: UTM 709920 x 5138568. Habitat type keyed to *Abies lasiocarpa/Menziesii ferruginea*. Dominant cover species were subalpine fir and Engelmann spruce. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated at 20 tons/acre. Distance to: water: 2 m; squirrel midden: approximately 75 m; trail: NA. One lodgepole pine snag (14" dbh) within 15 m radius of the set. Stand vertical structure evaluated as old forest multi strata. Open plate set on flat, open area.

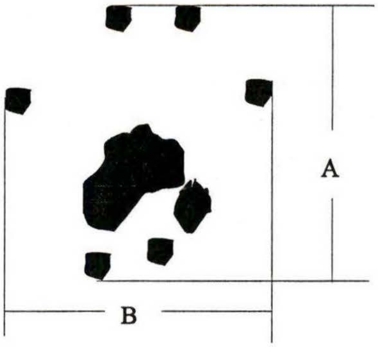
Table summarizes Bear/Fred Burr Ridge track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	31	86.1	86.1
MUER	1	2.8	88.9
Ursus Attack	1	2.8	91.7
MAAM	1	2.8	94.5
TAHU	2	5.5	100.0
	-------	-------	-------
Total	36	100.0	


LATENCY TO DETECTION

BEAR/FRED BURR RIDGE-1996

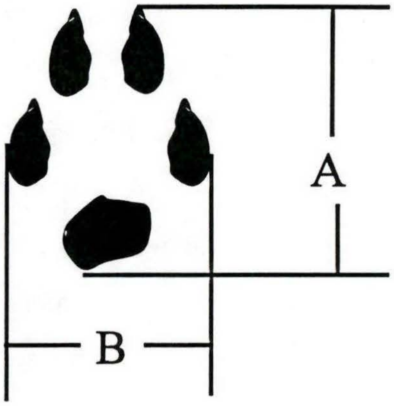
Species: *Tamiasciurus hudsonicus*
Site: Bear Face
Set #: One
Plate Type: Covered
Date Set: 07 July 1996
Collected: 11 July 1996
Bait: Partially Eaten
Measurements:
1) Forefeet: A = 15.5 mm
B = 14.4 mm



Species: *Tamiasciurus hudsonicus*
Site: Bear Face
Set #: One
Plate Type: Covered
Date Set: 07 July 1996

Collected: 13 July 1996
Bait: Partially Eaten
Measurements:
1) Forefeet: A = 13.7 mm
B = 13.3 mm

Species: *Mustela erminea*
Site: Bear Face
Set #: Three
Plate Type: Covered
Date Set: 07 July 1996
Collected: 17 July 1996
Bait: Not Eaten
Measurements:
1) Forefeet: A = 8.9 mm
B = 10.5 mm



Species: *Martes americana*
Site: Bear Face
Set #: Four
Plate Type: Covered
Date Set: 07 July 1996
Collected: 20 July 1996
Bait: Gone
Measurements:
1) Right Forefoot: A = 9.62 mm
B = 7.40 mm
C = 5.91 mm
Discriminant Score = -7.16

Big Creek Track Plate Survey

Survey Period: 08 July 96 - 20 July 96.
Survey Area: Sections #5, #9 and #10 Township T. 8 N. R. 21 W.

Plate #1: UTM 711766 x 5149929. Habitat type keyed to *Abies grandis/Linnaea borealis*. Cover species were an even mix of grand fir, lodgepole pine, and western larch. Overstory age class was Medium II and Large (>15" dbh). Coarse woody debris estimated at 10-13 tons/acre. Distance to: water: 75 m; squirrel midden: 8 m; trail: 14 m. One western larch snag (27" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a down log and baited with chicken.

Plate #2: UTM 712189 x 5149690. Habitat type keyed to *Pseudotsuga menziesii/Physocarpos malvaceus.* Dominant cover species was Douglas fir. Overstory age class was Medium II (15"-21" dbh). Coarse woody debris estimated at 10 tons/acre. Distance to: water: 15 m; squirrel midden: NA; trail: 6 m. Two Douglas fir snags (24" and 12"dbh) within 15 m radius of the set. Stand vertical structure evaluated between young and old forest multi strata. Covered plate set against a live Douglas fir and baited with chicken.

Plate #3: UTM 712627 x 5149610. Habitat type keyed to *Abies grandis/Linnaea borealis.* Cover species were an even mix of Douglas fir, lodgepole pine, and western larch. Overstory age class was Pole to Medium I (5"-15" dbh). Coarse woody debris estimated at 9 tons/acre. Distance to: water: 3 m; squirrel midden: NA; trail: 9 m. One Douglas fir snag (24" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a rock and baited with chicken.

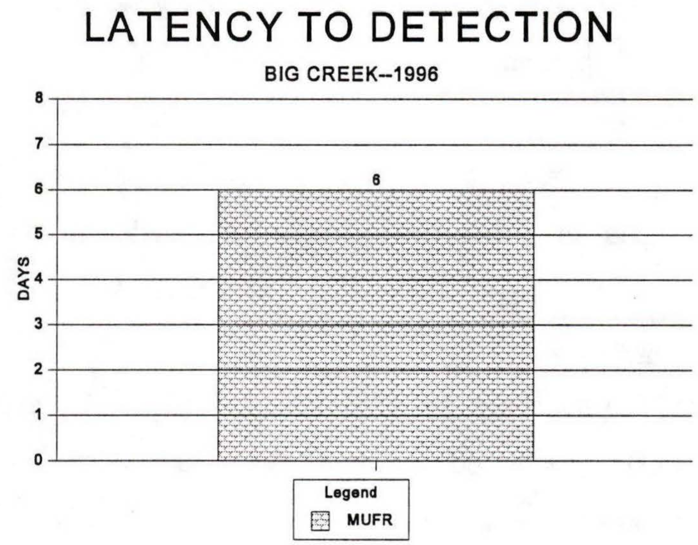
Plate #4: UTM 713179 x 5149613. Habitat type keyed to *Abies grandis/Linnaea borealis.* Dominant cover species was Douglas fir. Overstory age class was Medium I (9"-15" dbh). Coarse woody debris estimated at 7 tons/acre. Distance to: water: 22 m; squirrel midden: NA; trail: 8 m. One Douglas fir (12" dbh) within 15 m radius of the set. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a rock and baited with chicken.

Plate #5: UTM 713705 x 5149449. Habitat type keyed to *Abies grandis/Linnaea borealis.* Dominant cover species was lodgepole pine. Overstory age class was Pole (5"-9" dbh). Coarse woody debris estimated at 7-9 tons/acre. Distance to: water: 45 m; squirrel midden: 5 m; trail: 5 m. One western larch snag (30" dbh) within 15 m radius of the set. Stand vertical structure evaluated as understory reinitiation. Covered plate set against a downed log and baited with chicken.

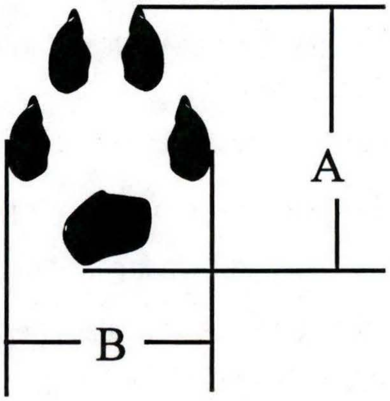
Open Plate: UTM 712415 x 5149533. Habitat type keyed to *Abies grandis/Clintonia uniflora.* Dominant cover species was Douglas fir. Overstory age class was Medium II (9"-15" dbh). Coarse woody debris estimated at 12 tons/acre. Distance to: water: 5 m; squirrel midden: 0 m; trail: 12 m. One western larch snag (26" dbh) within 15 m radius of the set. Stand vertical structure evaluated as between open stem exclusion and old forest multistory (grand fir regenerating in stand approaching midstory) Open plate set in a flat, open area and baited with chicken.

Table summarizes Big Creek track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	34	94.4	94.4
MUFR	2	5.6	100.0
	-------	-------	-------
Total	36	100.0	



Species: *Mustela frenata*
Site: Big Creek
Set #: Four
Plate Type: Covered
Date Set: 08 July 1996
Collected: 14 July 1996
Bait: Partially Eaten
Measurements:
1) Forefeet: A = 16.1 mm



B = 13.7 mm

Species: *Mustela frenata*
Site: Big Creek
Set #: Four
Plate Type: Covered
Date Set: 08 July 1996
Collected: 20 July 1996
Bait: Gone
Measurements:
1) Forefeet: A = 15.0 mm
B = 14.5 mm

Sweeney Creek Track Plate Survey

Survey Period: 08 July 96 - 20 July 96.
Survey Area: Section #19 Township T. 10 N. R. 20 W. and Section # 24 T. 10 N. R. 21 W.

Plate #1: UTM 714749 x 5165874. Habitat type keyed to *Abies lasiocarpa/Arnica cordifolia.* Dominant cover species were lodgepole pine and western larch. Overstory age class was Pole (5"-9" dbh). Coarse woody debris estimated at 11-13 tons/acre. Distance to: water: NA; squirrel midden: NA; trail: 10 m. Two western larch snags (19" and 24" dbh) within 15 m radius of the set. Stand vertical structure evaluated between closed stem exclusion and young forest multi strata. Covered plate set against a down log and baited with chicken.

Plate #2: UTM 715246 x 5165831. Habitat type keyed to *Abies lasiocarpa/ Arnica cordifolia.* Cover comprised of an even mix of Douglas fir, lodgepole pine, Engelmann spruce, and subalpine fir. Overstory age class was Pole to Medium I (5"-15" dbh). Coarse woody debris estimated at 13 tons/acre. Distance to: water: 11 m; squirrel midden: 0 m; trail: 10 m. Stand vertical structure evaluated as closed stem exclusion. Covered plate set against a downed log and baited with chicken.

Plate #3: UTM 715550 x 5165827. Habitat type keyed to *Abies lasiocarpa/ Arnica cordifolia.* Cover comprised of Douglas fir and Engelmann spruce. Overstory age class was Pole (5"-9" dbh). Coarse woody debris estimated at 13 tons/acre. Distance to: water: 8 m; squirrel midden: 15 m; trail: 25 m. Stand vertical structure evaluated as closed stem exclusion.

Covered plate set against a downed log and baited with chicken.

Plate #4: UTM 716293 x 516839. Habitat type keyed to *Pseudotsuga menziesii/Arnica cordifolia*. Co-dominant cover species were Douglas fir and western larch. Overstory age class was Medium I (9"-15" dbh). Coarse woody debris estimated at 15 tons/acre. Distance to: water: NA; squirrel midden: 5 m; trail: 15 m. One snag of unknown species (27" dbh) within 15 m radius of the set. Stand vertical structure evaluated as closed stem exclusion. Covered plate set against a snag and baited with chicken.

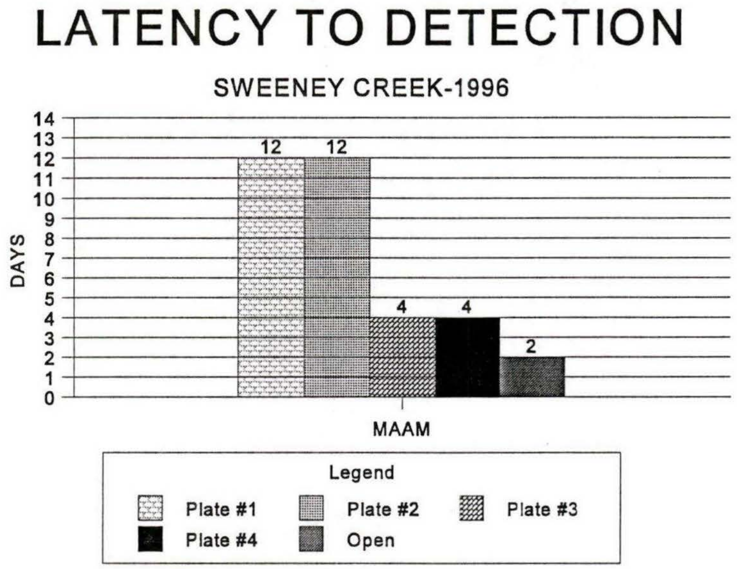
Plate #5: UTM 716587 x 5165631. Habitat type keyed to *Pseudotsuga menziesii/Arnica cordifolia*. Co-dominant cover species were Douglas fir and western larch. Overstory age class was Medium I (9"-15" dbh). Coarse woody debris estimated at 11 tons/acre. Distance to: water: NA; squirrel midden: 5 m; trail: 69 m. Stand vertical structure evaluated as young forest multi strata. Covered plate set against a live Douglas fir and baited with chicken.

Open Plate: UTM 715246 x 5165831. Habitat type keyed to *Abies lasiocarpa/ Arnica cordifolia*. Cover comprised of an even mix of Douglas fir, lodgepole pine, Engelmann spruce, and subalpine fir. Overstory age class was Pole to Medium I (5"-15" dbh). Coarse woody debris estimated at 13 tons/acre. Distance to: water: 18 m; squirrel midden: 29 m; trail: 10 m. Stand vertical structure evaluated as closed stem exclusion. Open plate set on flat, open area.
Table summarizes Sweeney Creek track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	24	66.7	66.7
MAAM	12	33.3	100.0
	-------	-------	-------
Total	36	100.0	

Species:	*Martes americana*
Site:	Sweeney Creek
Set #:	Four
Plate Type:	Covered
Date Set:	08 July 1996

Collected: 12 July 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 8.36 mm
B = 7.49 mm
C = 5.42 mm
Discriminant Score = -13.1



Species: *Martes americana*
Site: Sweeney Creek
Set #: Three
Plate Type: Covered
Date Set: 08 July 1996
Collected: 12 July 1996
Bait: Not Eaten
Measurements:
1) Left Forefoot: A = 6.86 mm
B = 6.33 mm
C = 5.18 mm
Discriminant Score = -23.9

Species: *Martes americana*
Site: Sweeney Creek
Set #: Three
Plate Type: Covered

Date Set: 08 July 1996
Collected: 14 July 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 9.33 mm
B = 7.35 mm
C = 5.68 mm
Discriminant Score = -8.86

Species: *Martes americana*
Site: Sweeney Creek
Set #: Four
Plate Type: Covered
Date Set: 08 July 1996
Collected: 14 July 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 8.30 mm
B = 8.02 mm
C = 5.20 mm
Discriminant Score = -11.9

Species: *Martes americana*
Site: Sweeney Creek
Set #: Four
Plate Type: Covered
Date Set: 08 July 1996
Collected: 16 July 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 8.93 mm
B = 7.02 mm
C = 6.57 mm
Discriminant Score = -10.9

Species: *Martes americana*
Site: Sweeney Creek
Set #: Four
Plate Type: Covered
Date Set: 08 July 1996
Collected: 20 July 1996
Bait: Gone
Measurements:

1) Left Forefoot: A = 8.10 mm
B = 7.10 mm
C = 5.48 mm
Discriminant Score = -15.5

Species: *Martes americana*
Site: Sweeney Creek
Set #: Three
Plate Type: Covered
Date Set: 08 July 1996
Collected: 20 July 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 9.57 mm
B = 7.46 mm
C = 6.55 mm
Discriminant Score = -6.62

Species: *Martes americana*
Site: Sweeney Creek
Set #: Two
Plate Type: Covered
Date Set: 08 July 1996
Collected: 20 July 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 8.85 mm
B = 6.50 mm
C = 5.32 mm
Discriminant Score = -14.1

Species: *Martes americana*
Site: Sweeney Creek
Set #: One
Plate Type: Covered
Date Set: 08 July 1996
Collected: 20 July 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 8.59 mm
B = 6.29 mm
C = 4.89 mm
Discriminant Score = -16.3

Snowshoe Falls Track Plate Survey

Survey Period: 20 August 96 - 03 Sept 96.
Survey Area: Sections #25 and #26 Township T. 11 N. R. 24 W.

Plate #1: UTM 686090 X 5173490. Habitat variables were not recorded at this site due to field technician injury. Extremely high level of blown down trees. Covered plate set against a down log and baited with chicken.

Plate #2: Approximately 50 m west of Plate #1. Set under a young (dbh @ 14 cm). Open plate baited with chicken.

Plate #3: UTM 685510 X 5173400. Habitat variables were not recorded at this site due to field technician injury. Covered plate set against a downed log and baited with chicken. Trailmaster camera system (TM 500 w/ Olympus camera) installed at this site 24 Aug 96. Camera set approximately 1 m up a spruce tree located 2 m east of track plates. Monitor parameters: p=1 (most sensitive), cd=1 (one photo per minute), and camera disabled between 12:00 and 16:00 (to avoid wasting exposures as afternoon sun heats forest floor and triggers monitor). Camera was checked on two day intervals. Batteries in both monitor and camera remained functional for the entire survey period (8 days). Twenty-nine exposures were recorded:

	Freq.	Percent
Bad Exposure	1	3.4
MAAM	2	6.9
MUER	11	37.9
NA	10	34.5
TAHU	1	3.4
TEST	3	10.3
VATH	1	3.4

Plate #4: Initially set approximately 50 m west of Plate #3. Moved on 28 Aug 96 to approximately 1 m east of Plate #3. Open plate baited with chicken.

Plate #5: UTM 685540 X 5172520. Identical site as LO02 camera site. Habitat variables were not recorded at this site due to field technician injury. Extremely high degree of windthrown mature trees. Closed plate set against a downed log and baited with chicken.

Plate #6: Approximately 50 m east of Plate #5. Set in a squirrel midden. Open plate baited with chicken.

Plate #7: UTM 684800 X 5172000. Extremely high degree of windthrown mature trees. Habitat variables were not recorded at this site due to field technician injury. Closed plate set against a rock and baited with chicken.

Plate #8: Approximately 1 m north of Plate #7. Set on a large rock. Open plate baited with chicken.

Plate #9: UTM 686420 X 5172460. Habitat variables were not recorded at this site due to field technician injury. Closed plate set against a large rock and baited with chicken.

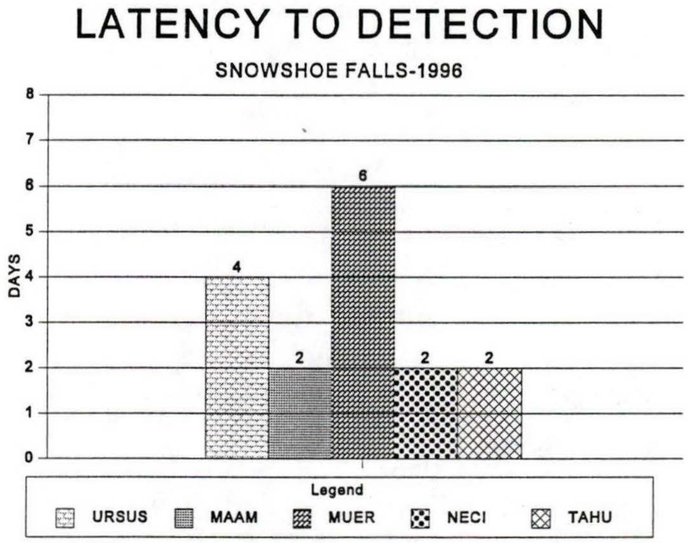
Plate #10: Approximately 8 m south of Plate #9. Open plate baited with chicken.

Plate #11: UTM 686750 X 5172760. Habitat variables were not recorded at this site due to field technician injury. Closed plate set against a downed log and baited with chicken.

Plate #12: Approximately 5 m north of Plate #11. Set under a spruce. Open plate baited with chicken.

Table summarizes Snowshoe Falls track plate survey results:

	Frequency	Percent	Cum Percent
No Tracks	54	75.0	75.0
Ursus	2	2.8	77.8
MAAM	7	9.7	87.5
MUER	6	8.3	95.8
NECI	1	1.4	97.2
TAHU	2	2.8	100.0
	-------	-------	-------
Total	72	100.0	



Species: *Martes americana*
Site: Snowshoe Falls II
Set #: Three
Plate Type: Closed
Date Set: 20 August 1996
Collected: 01 September 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 7.74
B = 6.25
C = 4.43
Discriminant Score = -21.04

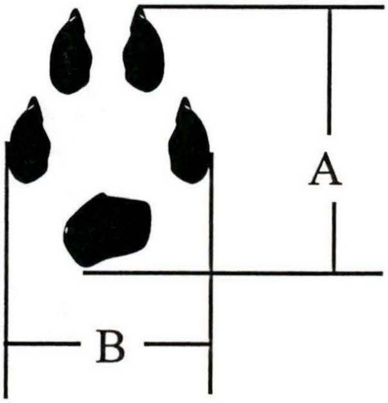
Species: *Martes americana*
Site: Snowshoe Falls II
Set #: Five
Plate Type: Closed
Date Set: 20 August 1996
Collected: 01 September 1996
Bait: Gone
Measurements:
1) Left Forefoot: A = 10.28
B = 6.33
C = 6.13
Discriminant Score = -7.29

Species: *Martes americana*
Site: Snowshoe Falls II

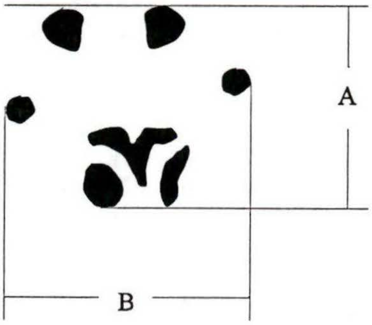
Set #: Seven
Plate Type: Closed
Date Set: 20 August 1996
Collected: 22 August 1996
Bait: Gone

Measurements:
1) Left Forefoot: A = 8.37
B = 5.56
C = 4.08
Discriminant Score = -20.35

Species: *Mustela erminea*
Site: Snowshoe Falls II
Set #: Three
Plate Type: Covered
Date Set: 20 August 1996
Collected: 24 August 1996
Bait: Gone
Measurements:
1) Forefeet: A = 14.44 mm
B = 12.56 mm



Species: *Neotoma cinerea*
Site: Snowshoe Falls II
Set #: One
Plate Type: Covered
Date Set: 20 August 1996
Collected: 22 August 1996
Bait: OK
Measurements:
1) Forefeet: A = 13.06 mm
B = 18.60 mm



RECOMMENDATIONS

Remote Sensing Camera Stations

1) As mentioned earlier, when using camera stations to survey for small mammals activity at the sites can be very intense. Checking the stations every other day, or even every day may not be unrealistic. When using TM 500 systems it may be advantageous to set longer camera delays. With longer camera delays it may be less likely to acquire multiple photos of the same individual. Also, because of the high activity and relatively small home range of small mammals (mice, voles, red squirrels, etc.), it may not be necessary to conduct the survey for as many days as a regular carnivore survey.

2) Winter survey efforts may yield better results as small mammals such as mice, voles, and shrews are more apparent in photos with a snow background versus a brown, cluttered background of the forest floor.

3) Winter survey efforts may also yield less numbers of photos with no identifiable species present. In order to pick up small mammals the monitors have to be set at their highest sensitivity level. At such levels they also pick up minute temperature changes as mid afternoon sunlight warms the forest floor. During the winter, snow cover minimizes the warming effect of the afternoon sun. During the summer, we recorded hundreds of photos between 12:00 and 16:00. Nothing was apparent in the photos except bright sun-warmed patches of forest floor. During the last camera survey the TM 500 was programmed to not trigger the camera between 12:00 and 16:00. During the entire survey period the station shot only one roll of film. The monitor, however, recorded hundreds of events, all but 29 being between 12:00 and 16:00. Most carnivores and small mammals, excluding *Tamias*, *Spermophilus*,and *Tamiasciurus*, are not active during this period so the probability of not detecting presence would be low.

4) Cameras stations detected three of the four target species. Lynx were not detected in this survey effort, nor in the 1995 survey effort. The habitats and locations of our survey effort most likely explain their absence from our results. Another possible reason is lynx are not enticed to a site by deer carcasses. One camera station in Grant Creek (Gr02), baited with fish, enticed two felids, a bobcat and a mountain lion, to within 1-2 m of the camera. Future survey efforts might test the effectiveness of fish for enticing lynx to stations.

5) The temperature data used in the comparison with battery life in this report was obtained from weather station miles away from the actual camera stations. The correlation between battery life and temperature may be greater than what appears in this report. Future testing may include the use of temperature data loggers (i.e. "Hobo Temps") at camera stations to more accurately monitor temperature regimes. Accurate estimates of battery lives for different temperature regimes would be valuable information to field technicians administering these survey techniques.

Tracking Plate Stations

1) Tracking plate stations are more effective winter-time survey tools because:

a) High fire danger of summer months will prohibit technicians from carrying the acetylene torch directly onto the survey site. If sites are very near to roads this may not be a problem. But, if survey sites are a long distance from roads, the carbon layer on the plates will most likely deteriorate before arriving at the sites, especially for the larger, open plates which tend to flex more when carried in a backpack. With less carbon, the plate's effectiveness at recording identifiable tracks decrease. A possible solution may be to build a wooden box such as Zielinski and Kucera (1995) describe to carry plates in a vehicle which could be strapped to the back.

b) Three of the four target species are opportunistic foragers. During summer months when small mammal populations are higher and edible berries are present in high densities marten, fisher, and wolverine may not be as likely to be enticed to a carcass. Winter months, when food resources are low, may present a better opportunity to entice such opportunist to the stations.

c) Tracks plates, especially open plates, are more likely to get soiled with debris and water during the summer than winter. Debris and water decrease the chances of recording an identifiable track from the plate.

LITERATURE CITED

Fischer, W.C. (1981). Photo guide for appraising downed woody fuels in Montana forest: Grand fir-larch-Douglas fir-western hemlock-western red cedar cover types. USDA For. Ser. Gen. Tech. Rep. INT-96, 53 p. Intermountain Forest and Range Experiment Station, Ogden, UT 84401.

Foresman, K.R. and D.E. Pearson. (1995). Testing of proposed survey methods for the detection of wolverine, lynx, fisher, and American marten in Bitterroot National Forest. Final Report for the Research Joint Venture Agreement INT-94918, USDA Forest Service, Intermountain Research Station, Missoula, Montana.

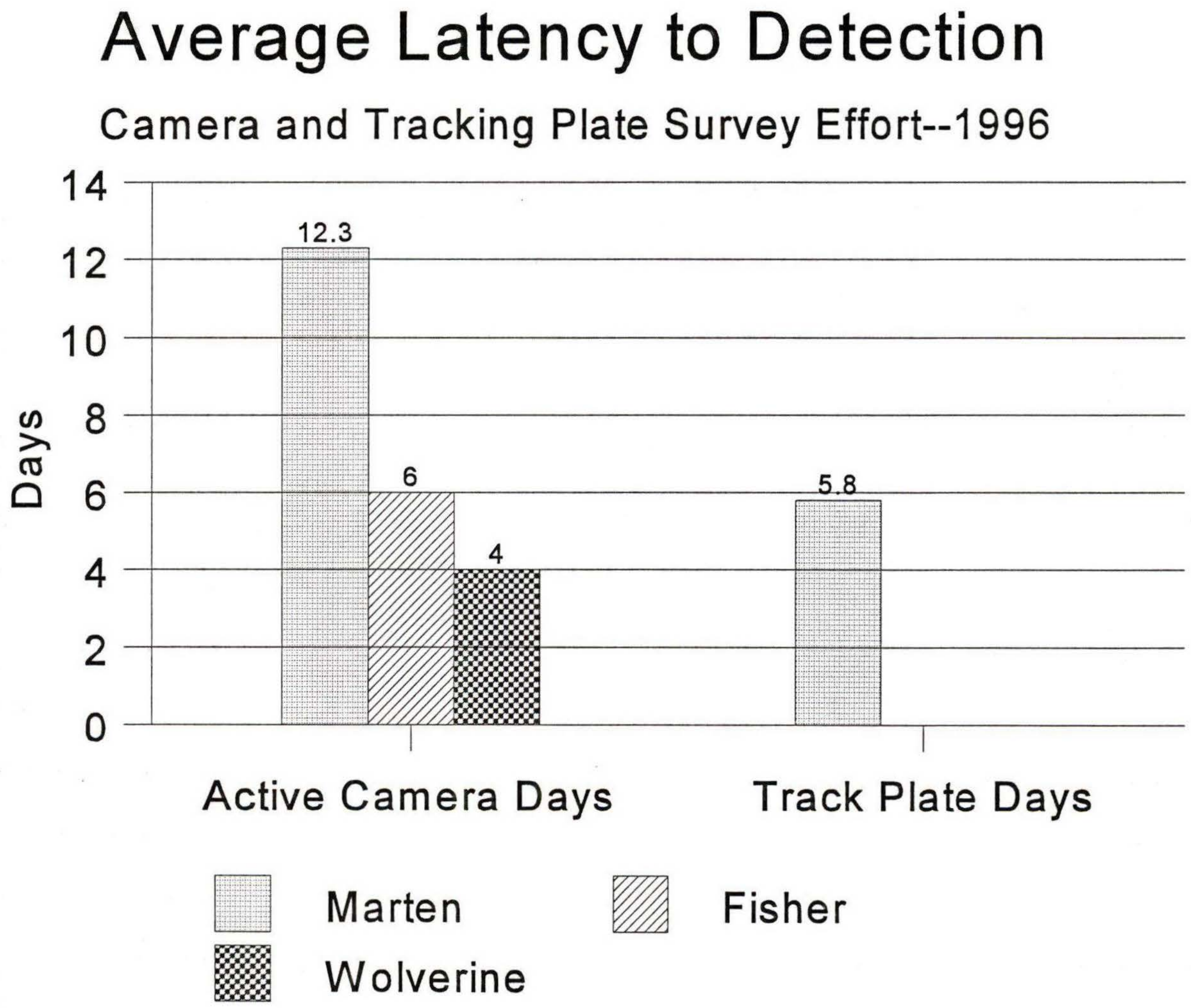
Kucera, T.E., A. Soukkala, and W.J. Zielinski. (1995). Remote photographic bait stations. Pp. 32-74. *In* Surveys methods for detection of lynx wolverines, fishers and martens [W.J. Zielinski and T.E. Kucera (eds.)]. USDA Forest Service, Draft Report.

O'Hara, K.L., Latham, P.A., Hessburg, P., and B.G. Smith. (1996). A structural classification for inland northwest forest vegetation. Western J. of Am. Forestry 11(3): 97-102.

Pfister, R.D., Kovalchik, B.L., Arno, S.F., and R.C. Presby. (1977). Forest habitat types of Montana. USDA For. Serv. Gen. Tech. Rep. INT-34, 174 p. Intermountain Forest and Range Experiment Station, Ogden, UT 84401

Zielinski, W.J. and T.E. Kucera, technical editors. (1995). American marten, fisher, lynx, and wolverine: survey methods for their detection. Gen. Tech. Rep. PSW-GTR-157. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 163 p.

Appendix 1. Graphic of Survey Latency to Detection.



Appendix 2. Species list for entire survey effort.

Family and species	Track Station	Camera Station	Observed sign or observed.
Ochontonidae			
Ochotona princeps	X		X
Leporidae			
Lepus americanus		X	X
Sciuridae			
Tamias ruficaudus		X	X
Tamiasciurus hudsonicus	X	X	X
Muridae			
Peromyscus maniculatus	X	X	
Neotoma cinerea	X	X	
Clethrionomys gapperi		X	
Canidae			
Canis latrans		X	X
Canis lupus			X
Ursidae			
Ursus americanus	X		X
Mustelidae			
Mustela erminea	X	X	X
Mustela frenata	X		
Martes americana	X	X	X
Martes pennanti		X	X
Mephites mephites	X		
Gulo gulo		X	X

Felidae			
Felis concolor		X	X
Lynx rufus		X	X
Cervidae			
Odocoileus virginianus			X
O. hemionus		X	X
Cervus elephus			X
Alces alces			X
Bovidae			
Oreamos americanus			X

Appendix 3. Habitat sampling data form.

Photo and Track Plate Habitat Variables

General Area: ______________________________ Date: ______________________

Section: _____________ Township ____________ Range ____________

Set No. _____________ GPS Coords: ______________________________

Map Datum: ____________ ______________________________

Habitat Type (Pfister et. al. 1977): ______________________________

Cover Type (dominant cover species): ______________________________

Age Class (15 m radius of set):

Layer	understory	midstory	overstory
Class			

where:	seedling/sapling	< 5" dbh
	pole	5"- 9" dbh
	medium I	9" - 15" dbh
	medium II	15" - 21" dbh
	large	> 21 " dbh

Coarse Woody Debris (15 m radius of set):

	10-20 cm	20-30 cm	30-40 cm	> 50 cm
Count				

(count individuals up to 20; then >20)

Coarse Woody Debris (Fischer, 1981): ___________________________

Distance to:

water ___________________________

squirrel midden _________________

trail/skid road __________________

Snags (> 20 cm; within 15 m radius):

dbh	species	type

If no snags within 15 m, distance to nearest snag: ______________

Vertical Structure (O'Hara et. al. 1996): ________________________

where classes equal:

stand initiation
open stem exclusion
closed stem exclusion
understory reinitiation
young multi-strata
old forest multi-strata
old forest single stratum

Notes: ____